Animal-assisted interventions in mainstream schools: What works?

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Publications and presentations resulting from this thesis

Work within this thesis has resulted in one published article so far:

- **Brelsford, V**., Meints, K., Pfeffer, K. & Gee, Nancy. (2017). Animal-Assisted Interventions in the Classroom - A Systematic Review. *International Journal of Environmental Research and Public Health, 22*, pii: E669, doi: 10.3390/ijerph14070669.

The systematic review at Chapter 3 represents part of the published work above and is re-used in adherence with the MDPI Open Access Information and Policy guidance: https://www.mdpi.com/about/openaccess

Work within this thesis has been presented at three conferences:

- July (2019) "Results from an RCT investigating AAI with children in mainstream and special needs' schools (including animal welfare screening)" (Meints, K., **Brelsford V.L**, Dimolareva, M., Gee, N., & Rowan, E.) Animal-assisted Interventions and Human Welfare Networking Day, The York Medical Society, York, UK (presented by Meints, K.).
- July (2018) "LEAD Risk Assessment Tool" (**Brelsford, V.L**, Dimolareva, M., Meints, K., & Gee, N.) International Society for Anthrozoology (ISAZ), Sydney, Australia (presented by Gee, N).
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Abstract

The inclusion of animals within the educational environment has increased in popularity in recent years, with many positive aspects being credited to the practice (Gee, Fine, McCardle, 2017; Fine, 2015). Whilst the value of animal-assisted interventions (AAI) has been reported for both psychological and physiological health of humans (for overviews and systematic reviews, e.g. Brelsford, Meints, Gee & Pfeffer, 2017; Gee, Fine & McCardle, 2017; Hall, Gee & Mills, 2016; Gee, Fine & Schuck 2015; Meaujean, Pepping & Kendall. 2015; Kamioka et al., 2014; O'Haire, 2013a), little is known about what effect AAI is having on school children as the practice is not routinely, nor systematically, studied or subjected to on-going external scrutiny (Gee, Fine & Schuck, 2017). Importantly, there is also a lack of rigorous research carried out into the effects of animal-assisted interventions which specifically focus on children's learning, development and personal wellbeing over time (Brelsford, et al., 2017; O'Haire, 2013b).

In order to achieve optimal outcomes for children, schools need to ensure interventions are effective. Additionally, such interventions require the attendance of live animals within educational settings, whose welfare needs must equally be upheld; it is therefore vital that animal-assisted interventions are assessed rigorously within the educational environment to ensure best outcomes for all (Brelsford, et al., 2017).

To address this issue, this research project comprises a longitudinal, randomised-controlled study carried out within mainstream schools in Lincolnshire, UK. Children were assigned to either a dog intervention, relaxation intervention or no treatment control condition. Intervention sessions were carried out for 20-minutes, twice per week, over 4-consecutive weeks. In order to assess cost efficiencies for schools, and the potential for less contact time for dogs, intervention-sessions were carried out as either one-to-one or group scenarios.

Baseline measures of children's cognitive, socio-emotional, physiological and behavioural functioning were completed through standardised tests and experimental tasks before and after interventions. These were repeated after 4 weeks of intervention, and again after 6-weeks, 6-months and 1-year. Standardised measures collected included socio-emotional measures of empathising/systemising, self-esteem and anxiety, cognitive measures of language (sentence comprehension & syntactic formulation) and cognition (non-verbal reasoning & spatial ability). Experimental tasks of categorisation, maths and a Stroop task were also employed. Physiological measures of baseline salivary cortisol were collected before and after intervention, and acute cortisol was measured by collecting cortisol before and after the first, the fourth and the last intervention session. Questionnaire data on children's behaviour at home, their sleep efficiency, family information, and pet-ownership details were collected through parent-questionnaires. Teachers also completed a classroom behaviour questionnaire for each child before and after intervention.

The project adhered to strict protocols for the application of dog-assisted interventions. Risk assessments were carried out for all school settings and care plans completed for all dogs taking part in the research. Dogs were recruited through Pets as Therapy (PAT) and underwent further behavioural assessment to ensure suitability to work with children; handlers, children and teachers also received safety training.

Repeated measures analysis of variance (ANOVA) was carried out to assess children's scores over time, with intervention condition, gender and dog ownership status factored into the analysis. Highly significant effects of learning were found in all groups over time, and no differences were found in scores between the schools taking part in the project. With respect to the intervention type, analyses revealed significant immediate effects of the individual dog intervention on cognitive functioning with improved spatial ability, reduced interference in the Fruit Stroop task and improved sentence comprehension.

Highly significant effects were also revealed in relation to children’s physiological measures of baseline salivary cortisol with children in the dog intervention showing no increase in cortisol before and after intervention, while both the relaxation group and the control group do show significant increases in stress levels over the school term. Acute cortisol levels significantly decreased after all dog interventions, too. This clearly highlights the successful stress-moderating effects of the dog intervention compared to other conditions.

Effects on behaviour were found with dog ownership a significant factor in children’s behaviour at home and within the classroom, as rated by teachers and parents. No significant effects were found for socio-emotional measures of empathy-systemising, self-esteem or anxiety, nor were any effects found for sleep efficiency.

Results are discussed relative to the hypotheses of the project with animal assisted interventions within the classroom environment showing some immediate positive effects on certain areas of learning but not all. No longitudinal benefits of dog-assisted interventions were evident across the study for any of the measures of cognition, language, socio-emotional or physiological functioning. Overall the results of the study support the Biopsychosocial model whereby multiple factors of biological, psychological and social functioning of the child are affected by interaction with a dog. Conclusions also discuss the results in light of theoretical underpinnings of the wider field of human-animal interaction research and recommendations are made for future study.

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PART ONE: Animal-Assisted Interventions in Schools

CHAPTER 1: Animal-assisted interventions in schools

1.1 Human-animal interaction in schools: brief background

Animals play an important role in children's social, emotional and cognitive development (e.g. Gee, Fine & McCardle, 2017; Fine, 2015; Endenburg & van Lith, 2010; Serpell, 1991). Children form close bonds to pets which also play a part in wider wellbeing, mental health and quality of life (Hawkins, Williams & Scottish SPCA, 2017; Gadomski, Scribani, Krupa, Jenkins, Nagykaldi, Ardis & Olson, 2015). The benefit of animal-assisted interventions (AAI) for both psychological and physiological health of humans has been demonstrated across a variety of ages and environments (for overviews and systematic reviews, e.g. Brelsford, Meints, Gee & Pfeffer, 2017; Gee, Fine & McCardle, 2017; Hall, Gee & Mills, 2016; Gee, Fine & Schuck 2015; Meaujean, Pepping & Kendall. 2015; Kamioka et al., 2014; O'Haire, 2013a).

As a result, schools are increasingly employing animals to support children's academic, behavioural and socio-emotional development, with many positive aspects being attributed to the practice (Gee, Fine & McCardle, 2017; Fine, 2015) .For example, Austrian schools employ the use of veterinarians and animal behaviourists to provide training for teachers so that they can bring their pet dogs into the classroom environment (Meints, Brelsford, Gee & Fine, 2017; Kotrschal & Ortbauer, 2003). However, while many educational practitioners routinely take their pets into the school environment, little is known about what effect this is having on the classroom as the practice is not routinely, nor systematically studied or subjected to on-going external scrutiny (Gee, Fine & Schuck, 2017). It is imperative therefore that the benefits of AAI be rigorously examined. Firstly, interventions must be effective and beneficial to children's development, and secondly, such interventions require the attendance of live animals whose welfare needs must equally be upheld.

Many types of animals are involved in intervention and therapeutic practice, including reptiles, small pets such as mice, guinea pigs and rabbits, as well as larger animals such as dogs, cats, horses and farm animals (Meints, Brelsford, Gee and Fine 2017; MacNamara & MacLean, 2017; Gee, Rawlings, O'Haire, Bennett, Snellgrove & Peralta, 2017; Gee, Fine & Schuck, 2015; Uttley, 2013).

Overall, the research evidence demonstrates that animal-assisted interventions with children can show improved outcomes in many areas of development such as attention, memory, emotional regulation and reading (e.g. Hediger, Gee & Griffin, 2017; Gee, Fine & McCardle, 2017; Hall, Gee & Mills, 2016; Gee, Fine & Schuck 2015; Meaujean, Pepping & Kendall. 2015; Kamioka et al., 2014; O'Haire, 2013a). However, practitioners should be careful in assuming that AAI works under all circumstances for all children. Research investigating Human-Animal Interaction (HAI) and Animal-Assisted Interventions (AAI) can be of varying quality, at times inconsistent and often lacking in rigorous design (see Brelsford, et al., 2017 for overview; see also O'Haire, 2013a), and some of the literature is anecdotal in nature (O'Haire, 2013b).

From an educational and developmental perspective, it would be a mistake to treat cognitive development, personal wellbeing and physical health as distinct features which stand in isolation of each other. Wellbeing is closely linked with educational achievement (Brooks, 2014; Gutman & Vorhaus, 2012; Suhrcke & de Paz Nieves, 2011) and it is widely accepted that educational attainment can bmatele affected by distress associated with mental health disorders in children and young people (Deighton, et al., 2018; Brännlund, Strandh & Nilsson, 2017; Murphy & Fonagy, 2012). Ultimately, children's wellbeing is not just about physical health but includes a variety of psychological factors and wider social functioning skills. The constitution of the World Health Organization (WHO) asserts "health is a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity" (WHO, 1948 p.1). Crucially, social and emotional skills are important as a foundation for success, health and balance in life and can improve long-term health and wellbeing, educational attainment, employment success and help avoid behavioural and social difficulties (Clarke, Morreale, Field, Hussein, & Barry, 2015).

Schools are well placed to support children's and young peoples' mental health. Accordingly, the new Ofsted framework (2019) has a key focus around the child's personal development: "The curriculum and the provider's wider work support learners to develop their character – including their resilience, confidence and independence – and help them know how to keep physically and mentally healthy" (Ofsted, 2019, Section 28, p. 11). A recent summary of children's mental health in the UK states that one in eight (12.5%), 5-to 19-year-olds had at least one mental health disorder, and 5% had two or more (Sadler, et al., 2017). Consequently, costs of the care provided by the Child and Adolescent Mental Health Service (CAMHS) through community-based services were estimated at £4.8 million per 100,000 population (age 0-18yrs) (NHS, 2018). Trends in data for 5- to 15- year-olds have shown a steady increase in the prevalence of low wellbeing from 9.7% in 1999 to 11.2% in 2017, with a particular increase in emotional type disorders (Sadler et al., 2017).

It is therefore of great importance that in addition to ensuring high standards of education, policy makers and school leaders work to reduce psychological stressors and to build resilience across childhood populations. Crucially, interventions must be appropriate and effective in order to provide best outcomes for the child, but also to work cost-effectively as schools are forced to manage ever tighter budgets (Williams & Grayson, 2018; House of Commons, Committee of Public Accounts, 2017).

Alongside AAI, relaxation and yoga techniques have become increasingly popular as interventions within the school environment to improve both mental and physical health (e.g. Waters, Barsky, Ridd & Allen, 2014; Ferreira-Vorkapic, Feitoza, Marchioro, Simoes, Kozasa & Telles, 2015). Such interventions have been shown to improve stress regulation across a variety of standardised measures (Telles, Singh, Bhardwaj, Kumar & Balkrishna, 2013; Hagen & Nayar, 2014; Mendelson, Greenberg, Dariotis, Gould, Rhoades & Leaf, 2010) including significant decreases in the stress hormone cortisol (Tang et al., 2007). Research has shown that certain types of yoga and meditation enhance performance on tasks that involve a series of functions such as selective attention, concentration and mental flexibility in addition to psychomotor speed (Sarokte & Rao, 2013; Pradhan & Nagendra, 2009; Sarang & Telles, 2007). Broderick and Metz (2009) found that girls participating in a school-based mindfulness program demonstrated increased feelings of calmness, relaxation and self-acceptance. Whilst differences were observed between novice and expert practitioners, effects such as heightened empathetic awareness can result from altered activation of neural circuits during meditation (Lutz et al., 2008). Interestingly, regulation of stress through cortisol reduction, improved selective attention and concentration, increased calmness and improved self-acceptance have also been recognised as positive outcomes of human-animal interactions (Beetz, Kotrschal, Turner, Hediger, Unväs-Moberg & Julius, 2011; Beetz, Julius, Turner & Kotrschal, 2012 ; O'Haire, McKenzie, Beck & Slaughter, 2015; Gee, Sherlock, Bennett & Harris,2009; Gee, Crist & Carr, 2010; Anderson & Olsen, 2006; Hergovich, Monshi, Semmler & Zieglmayer, 2002; Kotaschal & Ortauber, 2003). In this respect, animal-assisted interventions may also be ideally placed to provide effective support for a wide range of interventions within the school setting.

1.2 Terminology used to define Animal-Assisted Interventions

Before turning attention to the details of the current study, it is important to distinguish between the differences in terminology used to describe human-animal interactions employed across different contexts. Whilst the terms animal-assisted therapy (AAT), animal-assisted intervention (AAI) and animal-assisted education (AAE) may often be used interchangeably when referring to human-animal interactions within school settings, there are clear distinctions between them, as set out in the International Association of Human-Animal Interaction Organisations IAHAIO White paper (2018). Animal-assisted therapy (AAT) is a goal-oriented programme in which the animal meets certain criteria in order to tailor the therapy to the needs of the patient. The intervention is directed by a qualified therapist who holds a specific expertise in the type of therapy being employed. Similarly, animal-assisted education (AAE) is a structured, goal-oriented, and planned intervention delivered by an educational or related professional. Animal-assisted interventions (AAI) or animal-assisted activities (AAA) may be less controlled (from the perspective of the requirements of the animal during the session); the animal is present to interact with the person receiving intervention in a more mutual and shared interaction (Fine, Tedeschi & Elvove, 2015; Kruger & Serpell, 2006). Ensuring a distinction between the relevant terms is important as the type of service offered needs to meet the differing needs of people (Fine, 2015; Thodberg, Berget & Lidfors, 2014). Further work by Fine and Macintosh (2016) has provided a more in-depth definition of the various, and more specific, types of animal-assisted interventions which come under each of the main themes of AAA, AAT and AAE (see Figure 1 for overview).

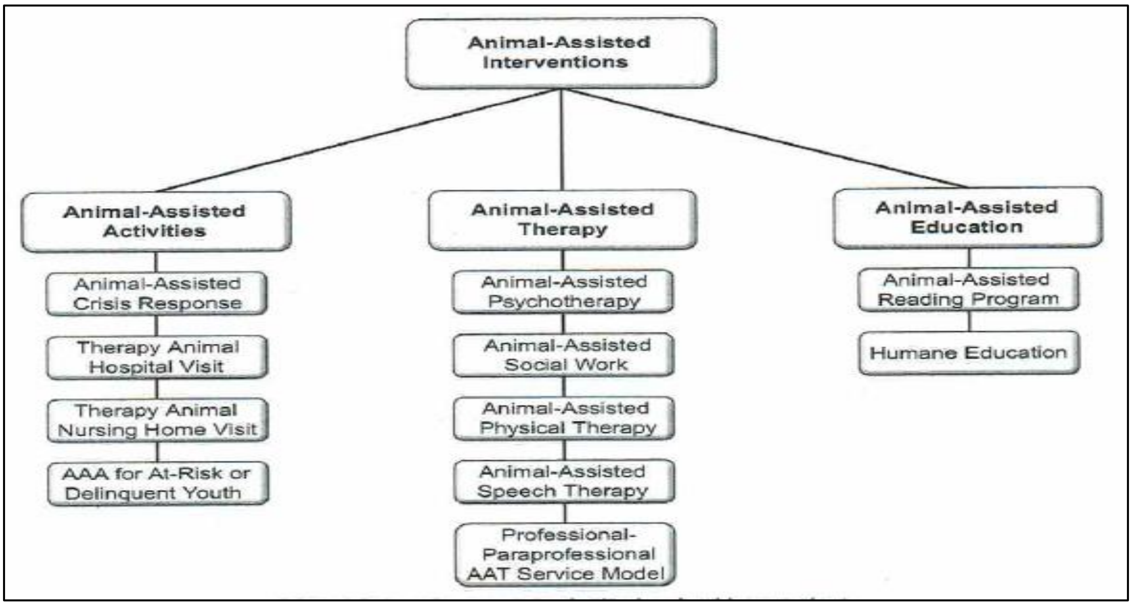

Figure 1. Types of animal-assisted interventions which come under each of the main themes of AAA, AAT and AAE (Fine and Macintosh, 2016)

In line with Fine (2015), and Kruger and Serpell (2006), the interventions reported in the current project were conducted within educational settings, but were not tailored to meet specific needs of individual children, and not carried out by a therapist or teacher, but by a researcher. Hence, the current research is assigned the label 'animal-assisted intervention' or 'AAI', and this term will be used throughout this thesis in relation to all aspects of the research carried out within this project.

1.3 Organisation of this thesis

This thesis contains eleven chapters. The first chapter consists of a short introduction and defines key terms for the framing of human-animal interaction research. Chapter 2 provides the theoretical background and critiques the appropriateness of each of the theories being considered. Chapter 3 demonstrates the breadth and impact of animal-assisted interventions carried out within educational environments through a systematic literature review. Recommendations are made for safe and effective working practices whilst carrying out animal-assisted interventions in schools. The review summarises the extent of existing literature and compares details across studies in order to inform areas of research. Chapter 4 highlights the gaps in the literature and develops the topics of the current empirical study. It also provides a more in-depth view of the questions investigated within this thesis. Hypotheses for the thesis are presented at the end of this chapter.

Chapter 5 contains the Methods section with participant information, materials and procedures, ethics, safety and welfare considerations.

Chapter 6 reports the analysis of data relating to cognitive development and includes the assessment of non-verbal reasoning (NVR), spatial ability (SA) and a special non-verbal composite (SNC) which consists of the two measures combined. These functions are measured through the standardised British Ability Scales (BAS3) toolkit. Children are also assessed on a maths task and a Stroop task to inform the effect of dog-assisted intervention on these aspects of cognitive functioning.

Following on from this, chapter 7 assesses children's language abilities, specifically, sentence comprehension and syntactic formulation through the Assessment of Comprehension and Expression (ACE) standardised toolkit. This chapter also includes a categorisation task looking at the effects of animacy in relation to AAI.

In order to test the effects of a dog-assisted intervention on the wider functioning of children, chapter 8 includes a series of social, emotional and behavioural measures. These consist of self-esteem measured through the Battles Culture Free Self-Esteem Inventory (CFSEI), empathy and systemising through the Empathy/Systemising Quotient (EQ-SQ) and anxiety measured through the Revised Children's Manifest Anxiety Scale (RCMAS). In addition teachers were asked to complete the Child Behaviour Rating Scale (CBRS) and parents were asked to complete a behaviour at home questionnaire to measure children's behavioural functioning. These measures were collected either as part of the longitudinal testing in school, or through parent and teacher ratings before and after the four-week interventions.

Children’s physiological response to the dog and relaxation interventions are analysed at chapter 9 through the presentation of baseline measures of cortisol taken at the start of the longitudinal study and again when interventions had ended. Results are also presented for acute cortisol measures collected before and after intervention sessions, one, four and eight.

Chapter 10 presents children’s sleep data which was collected through a sleep diary completed by children and their parents at home over the course of the intervention for a period of 4-weeks.

The discussion in chapter 11 brings together the results to build a coherent picture of the findings, relating each back to the original research questions and theoretical backgrounds surround AAI.

Lastly, chapter 12 concludes the results, comments on the limitations of the study and highlights the next steps for future research within the field of human-animal interaction, and animal-assisted interventions specifically.

CHAPTER 2. Animal-assisted interventions: Theoretical frameworks

2.1 Humans' relationship with dogs - historical perspective

The enduring nature of humans' social relationships with dogs (*Canis lupus familiaris*) can be seen through domestication of the grey wolf (*Canis lupus*) dating back some 16,000 years (Morey, 2010; Driscoll, Macdonald & O'Brien, 2009; Coppinger & Coppinger, 2001). There is debate around the evolving domestication of dogs, with some suggesting the process goes back much further to as much as 33,000 years (Germonpré et al., 2009, 2017) although this is still in contention due to isolated evidence (Perri, 2016). A more recent genome study now asserts a time frame for domestication of between 20,000 to 40,000 years ago (Botigué, et al., 2017).

Nevertheless, a wealth of archaeological evidence exists to demonstrate the place of pets, and dogs in particular, in co-habitation with humans across the world (Pierotti & Fogg, 2017; Clutton-Brock, 1995; Serpell, 1995). For example, dogs are often found buried alongside humans (Morey, 2010). Some of the earliest examples of the burial of a domestic dog in Germany date back 14,000 years to the late Palaeolithic age (Morey, 2010; Pierotti & Fogg, 2017) and in Israel dating back some 12,000 years (Davis & Valla, 1978) (for overview see Crockford, 2005). In light of such examples it is clear that the phenomenon of dog ownership and close human-animal relationships is not a new one.

Indigenous stories from around the globe also support the enduring relationship of human-animal relationships, and the domestication of wolves (Pierotti & Fogg, 2018;Serpell, 2010). The domestic dog (*Canis lupus familiaris*) has succeeded in forming and maintaining a close bond with humans. Researchers offer a variety of explanations to account for these close relationships, citing the beneficial roles for each concerned. A convergent evolution between humans and dogs may account for the social and cognitive abilities which have developed between the two (Miklósi, Polgárdi, Topál, & Csányi, 2000; Miklósi, Topál, &

Csányi, 2004) with selective pressures acting to drive more complex social functions. For many, domestication has resulted through a process of co-evolution whereby rather than the relationship between human and wolf communities being one of competition, both sides would have taken advantage of the other (Pierotti & Fogg, 2017). Evidence to support this view can be found in research demonstrating that dogs are in tune with the human, that is, they are good at responding to human social gestures, human gaze and other cues (e.g. Piotti & Kaminski, 2016; Racca, Amedei, Ligout, Guo, Meints & Mills, 2010; Racca, Guo, Meints & Mills 2012; Guo, Meints, Hall & Mills, 2009; Hare & Tomasello, 2005) and also demonstrate a rapid integration of new behaviours following from the consequences of responding to them (Udell, Dorey & Wynne, 2008). This rapid integration of new social behaviours may be driven by the dogs' dependence on humans for food (Udell, et al., 2008). However, convergent evolution does not necessarily bring with it innate functions such as the ability to read complex social cues. Instead, ontogenetic development is still a key requisite to the reciprocal relationships between humans and animals. For example, whilst research demonstrates the ability of domestic dogs to discriminate between positive and negative human emotions (Albuquerque, Guo, Wilkinson, Savalli, Otta & Mills, 2018), this ability does not appear to be an inbuilt and automatic process for humans, as both children and adults are unable to determine stress signalling behaviours in domestic dogs, regardless of dog ownership and prior experience of living with a dog (Meints, Brelsford & DeKeuster, 2018).

While a historical perspective can lend insight into the processes which have shaped humans' current relationship with dogs, such complex and dynamic relationships cannot be fully understood without a theoretical framework that integrates the distinct areas of processing activated during human-animal interactions. Such a framework should be able to account for what we already know about the human-animal relationship and it should have the capacity to integrate and support new findings as uncovered through robust empirical research.

2.2 Biophilia Hypothesis

The Biophilia Hypothesis was presented by E. O. Wilson in 1984 within the topic of sociobiology to describe humans' innate attraction to living things. The theory puts forward an evolutionary perspective of a genetically driven pre-disposition for humans to attend to other life forms and nature. This innate attention that humans pay to animals and the natural world is supposed to have evolved due to its beneficial effects on survival (Wilson, 1984). While the focus often lies on the positive attraction of humans to animals and other living things, Wilson's theory also posits the adaptive value of negative attention to animals, such as fear of snakes to aid instinctive survival mechanisms. Biophilia is seen as "the natural drive that stimulates individuals to seek out and form relationships with animals" (Fine & Weaver, 2018).

Research evidence in support of the Biophilia hypothesis and its application to the human-animal bond has been shown in research involving both infants and adults. The importance of a bias to animals and living things can be seen during early development, with conceptual distinctions between animate and inanimate objects being fundamental to early cognitive processing (Goswami, 1998; Mandler & Bauer 1988; Mandler, Bauer & McDonough, 1991; Mandler & McDonough, 1993). Infants gaze-follow and make sounds towards live pets more than robotic ones (Kidd & Kidd, 1987), the first words produced by infants are often those relating to animal names and sounds (Nelson, 1973; Caselli, Bates, Casadio, Fenson, Fenson & Sanderl, 1995) and young children attend more to live animals than stuffed toys, speak to them differently, with parents sharing more joint attention with their children towards live pets than stuffed animals (LoBue, Bloom, Sherman, Axford &

Deloache, 2013). The preferential importance of animals to humans can be seen in greater amygdala activation found in people when viewing photographs compared to people, objects and landmarks. This suggests a category-specific preference for animals in the processing of emotion (Mormann, et al., 2011).

An attentional bias towards animals is also evident in studies looking at threat-relevant versus threat-irrelevant stimuli. The importance of such an innate mechanism is fundamental to survival, as Ohman, Flykt & Esteves (2001) demonstrated in their research. They showed that people notice threat-relevant stimuli such as snakes faster than non-threatening items. Infants also demonstrate this mechanism, noticing the presence of snakes and spiders faster than other stimuli such as flowers or frogs (LoBue, 2010; LoBue & DeLoache, 2008). New, Cosmides and Tooby (2007) found that participants were faster at processing changes in animal images than other inanimate categories regardless of experience, concluding an evolutionary category-specific mechanism for animate stimuli. Not all threat relevant stimuli are processed in such a manner, for example as already stated, misunderstandings of signalling behaviours in dog body language do not appear to be an innate ability in either infants or adults (Meints, et al., 2018).

The Biophilia hypothesis is a meta-theory and has the advantage of providing a wide and all-encompassing framework. This allows for the many areas of human functioning, and the complex interactions between multiple functions to be incorporated within the theory. However, this does not assist the researcher in narrowing down the specific pathways involved in human-animal interactions without the hypothesis providing more specific predictions.

The hypothesis asserts a human pre-disposition of attraction to nature and animals. At the same time, this is difficult to align with a variety of human practises and attitudes, not least, that of cruelty towards animals “the non-accidental, socially unacceptable behaviour that causes pain, suffering or distress to and/or the death of an animal" (Ascione & Shapiro, 2009: 570). Kahn (1997) suggests that Biophilia provides a valuable framework through which to examine children's developmental affiliation with nature. Cruelty towards animals is perpetrated by both children and adults and is often cited within forensic literature (Dadds, Whiting & Hawes, 2006; Faver & Strand, 2003). However, the fact that legislation such as the Animal Welfare Act (2006) (Legislation.Gov.UK, 2015) is in place, and that there are hundreds of animal rescue centres across the UK alone, shows the extent of such lack of compassion towards domestic, wild and farm animals. Cruelty is often socially acceptable (Ascione & Shapiro, 2009) as demonstrated through the mass factory farming of animals and such activities as the use animals for sporting purposes (League Against Cruel Sports Impact Report, 2018).

In addition, people's attitudes towards animals are not always favourable. Individual personality traits affect a person's beliefs towards animals (Hawkins, Hawkins, Caceres Castellanos & Williams, 2017; Galvin & Herzog, 1998) and attitudes can vary based on cultural background (Gray & Young, 2011; Herzog, 2014; Kellert, 1993). It is therefore difficult to apply Biophilia as a framework for human-animal interactions overall in the light of wider cognitive and affective factors that do not necessarily align with a biologically driven, evolutionary pre-disposition of attraction to nature and animals.

2.3 Attachment theory

Beetz (2017) suggests Attachment theory (AT) as one of the possible frameworks for the explanation of effects seen in human-animal interactions, and that this also encompasses the regulation of stress and effects on emotion through social support. Models of attachment describe the innate, biologically driven emotional bond between offspring and caregiver which develops over time (Bowlby, 1969, 1973, 1980; Ainsworth, 1964; Ainsworth, Blehar, Waters & Wall, 1978). The model also emphasises the significance of the relationship, and its establishment and maintenance for survival. Early relationships with primary caregivers are thought to determine the type of attachment a child establishes with implications for future relationships and behavioural outcomes (Ainsworth, 1964; Thompson & Gullone, 2008). Yet this stance does not take into account the importance of understanding how individual differences and the impact of wider external and societal factors impact on attachment outcomes, and not solely those of the caregiver (Rutter, 2002). Attachment theory is based on the premise that an innate emotional bond is formed between offspring and caregiver, that the caregiver acts as a secure base from which the offspring can explore, the offspring seeks proximity to the caregiver (through the secure base) and that the relationship is bi-directional (Schofield & Beek, 2014). The theory places importance on the proximity seeking of the child, and the caregiver as a safe-base but fails to place importance of the physiological aspects of such social interactions. Critically, physiological patterns relative to different attachment styles are not well understood (Julius, Beetz, Kotrschal, Turner & Uvnäs-Moberg, 2013) which means it is difficult to draw conclusions of how AAI interactions may differ or benefit specific attachment profiles. Regardless of its criticisms, attachment theory has had a positive impact on child research and policy (Cassidy, Jones & Shaver, 2013). Policy-makers are now aware of the importance of parenting practices. This has enabled changes in social policy, in that a sensitive and nurturing environment is key to secure development of the child and importantly. The theory has allowed the application of preventative interventions to support sensitive parenting (van Ijzendoorn, 2014).

In the same respect as caregivers provide comfort and protection during stressful events for children, pets may also be seen to provide components of attachment to humans (Serpell, 1991; Sable, 1995). Beck & Madresh (2008) found that pets provided a consistent source of attachment security, with respondents reporting more security on every measure with their pets, in contrast to ratings of their romantic partners. People with higher ratings of attachment to their pets also placed their pets higher in their attachment hierarchy; such as in relation to romantic partners, siblings and friends (Meehan, Massavelli & Pachana, 2017). Research also demonstrates that the human can serve as a safe-base for their dog, and that behaviours between the two often represent attachment type patterns of interaction (Solomon, Beetz, Schoberl, Gee & Kotrschal, 2018; Horn, Huber & Range, 2013; Palmer & Custance, 2007). This also appears to work both ways, with dog owners reporting that they used their dog as a safe haven, turning to them for comfort in times of emotional distress (Kwong & Bartholomew, 2011; Kurdek, 2008; 2009). Additionally, similar to the loss of a human companion, pet owners suffer grief following the death of their animal suggesting a close emotional attachment between human and animal (Gosse and Barnes, 1994) and humans often mention pets in obituaries, in addition to the relatives they are leaving behind (Wilson, Netting, Turner & Olsen, 2015). Individual differences are also evident in attachment to pets, and therefore influence pet-related cognitions, emotions and behaviour, and are comparable with attachment patterns in human relationships (Zilcha-Mano, Mikulincer & Shaver, 2011; Payne, Bennett & McGreevy, 2015).

One area which must be reconciled in order to apply attachment theory as a framework for the application of human-animal interventions is the fact that the theory asserts the development of a bond with significant others over time and is not simply an automatic and instant effect. In contrast, many of the results found during research investigating the effects of human-animal interactions are often immediate, may include only single test sessions, and where interactions do occur on more than one occasion, may often include several animals rather than repeated exposure to the same animal. This is not to say that attachment theory does not provide a framework for pet ownership and wider human-animal interactions, but it cannot account fully for short-term, single exposure of human-animal interactions that produce effective results in areas such as categorisation (Gee, Gould, Swanson & Wagner, 2012b), motor tasks (Gee, Harris & Johnson 2007; Gee et al., 2009) and reading (Grigore & Rusu, 2014). In this respect Attachment theory may be useful in understanding some of the factors involved in effects of human-animal interventions, especially in relation to pets and companion animals, however, its ability to account for effects in AAI may be limited based on the above discussions.

2.3.1 Attachment theory and social support

Attachment can also be seen as a form of social support and is tightly coupled with stress regulation (Beck & Katcher, 2003). The concept of support may be more valuable as a framework for understanding human-animal relationships, as opposed to attachment (Collis & McNicholas, 1998) as the animal is always a consistent, dependable and non-judgmental companion (Serpell, 2004, 2010; Wells, 2009). Social support can also be seen to include the role of physical contact (Julius, et al., 2013; Ditzen Neumann, Bodenmann, von Dawans, Turner & Ehlert & Heinrichs, 2007). Inclusive within this wider social network, the animal can be seen to provide and support interpersonal relationships (Meehan, et al., 2017; Fine & Beck, 2015; Smolkovic, Fajfar & Mlinaric, 2012; McNicholas & Collis, 2000, 2001; Odendaal, 2000), and act as a social buffer (O'Haire, et al., 2015; Julius et al., 2013; Gee et al., 2007; Serpell, 1996). Social support may therefore lends itself as framework for the implementation of animal-assisted interventions. It is difficult to tease social support from attachment theory, as both encompass many of the same factors which are closely related, however, social support theory may be more appropriate in accounting for the effects of short-term, single exposure human-animal interactions that occur through the physiological systems of both the human and animal.

2.3.2 Attachment theory and Neurophysiological hypothesis

Julius, Beetz, Kotrschal, Turner & Uvnäs-Moberg (2013) bring together the physiology of attachment and caregiving to provide an overarching model for the attachment model to be applied to human-animal interactions. The hypothesis is an integrative framework which is based on the understanding that physiological and endocrinological patterns displayed by an individual are a reflection of their past experiences of close relationships. In turn, this will affect interactions with significant others, including interactions and relationships with animals. The mechanisms underlying these interactions can therefore be applied to the bonds formed during human-interactions and account for outcomes seen in such research.

Whilst the Attachment and Neurophysiological hypothesis provides a comprehensive framework for the application of human-animal interactions, several areas of criticism already discussed would still relate to this theory. Any theory with attachment included provides an ideal model for the effects seen in pet ownership and companion animal studies, or indeed those whereby interventions with the same dog are repeated over time, however, single intervention, one-off studies or those with many different animals are harder to accommodate within this model.

2. 4 Biopsychosocial model

Friedmann and Gee (2017) suggest that the Biopsychosocial model of stress reduction could be an effective model for understanding how multiple factors contribute towards the effects of human-animal interactions (see Figure 2). The Biopsychosocial model consists of a framework which encompasses the biological, psychological and social functions of an individual and was first proposed by George Engel in 1977 as a way of understanding how a person’s thoughts and feelings also impact in the biological dimensions of illness (Borrell-

Carrió, Suchman & Epstein, 2004). The model has multiple levels of organisation, however, these are interactive and not dependent on each other but instead interact in a dynamic fashion (Borrell-Carrió, et al., 2004). The model allows for interaction between biological, psychological and social factors, either in isolation or simultaneously, and oversight of how these can impact on the other functions (Friedmann & Gee, 2017; Wade & Halligan, 2017).

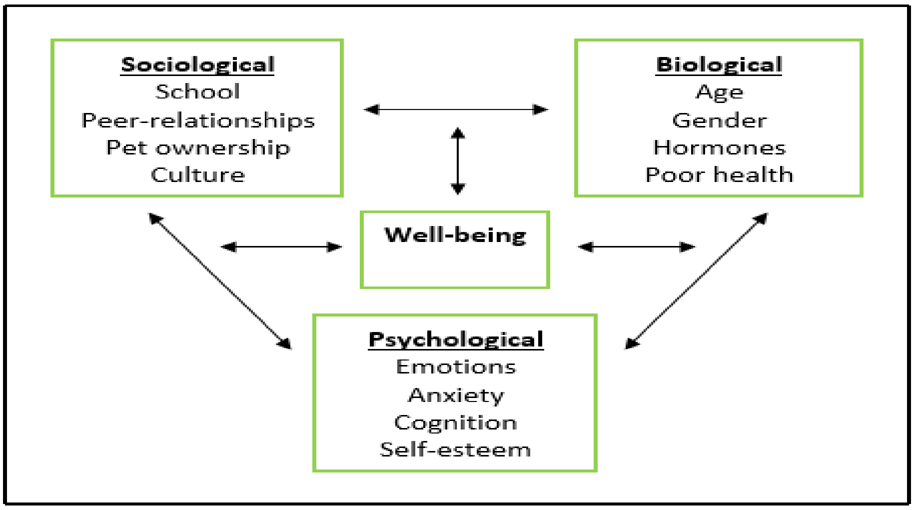

Figure 2. The Biopsychosocial Model

Fundamentally, the Biopsychosocial model allows individuals' subjective experience to be included, in addition to more objective measures such as physiological outcomes, in order to inform person-centred outcome measures Each of the biological, psychological and social factors are well documented within the AAI literature as having significant outcomes on human welfare (for wider background see Friesen, 2010; Maujean, et al., 2015; Kamioka et al., 2014; Busch, Tucha, Talarovicova & Fuermaier,2016; Hoagwood, Acri, Morrissey & Peth-Pierce, 2016, Davies et al., 2015 & O'Haire, 2013a). However, the literature does not present a coherent picture of the mechanisms at work during such interactions and the application of a theoretical framework in which to ground the research outcomes.

The Biopsychosocial model allows a holistic view of the processes taking place within human-animal interactions. Interactions between biological, psychological and social factors are complex and dynamic; the theory allows such dynamic interactions to be considered together in order to narrow down the mechanisms responsible for the beneficial effects of human-animal interactions. Interplay between these factors is evident in human-animal interaction studies such those conducted by O'Haire, et al., (2015) and Beetz, et al., (2011; 2012) whereby physiological responses, in addition to wider individual factors are measured and brought together to narrow down the mechanisms at work during HAI sessions. A central criticism of the model is that it is person-centred and incorporates factors such as experience, attitudes and a person's role in the context of society, which is a "temporal context" (p. 998) and is not easily measured as it changes with time and in the face of a persons' decision making (Wade & Halligan, 2017). However, this argument would equally apply to any theoretical model or framework, as any measures taken from any human or animal can only ever represent a snapshot, and these factors change as interventions or medicines are administered and measured longitudinally. A further refinement of the Biopsychosocial model has been put forward by Lehman, David and Gruber (2017) who proposed the Dynamic Biopsychosocial Model. This dynamic model allows for the interaction of wider societal and interpersonal factors that influence health over time to be considered, in addition to the influence of time. This extension of the theory may also be applied as a framework for the application of human-animal interactions.

Human-animal relationships are complex and dynamic. Applying a theoretical framework which is capable of integrating and supporting the factors responsible for the effects found in such interactions is therefore challenging. Understanding the processes at work during human-animal interactions, and the type of factors that impact on these effects is important. Appreciation of what works, and how, has the potential to further refine the field of research, therapy and animal welfare practices which is beneficial for all parties involved. The current research will investigate cognitive, language, behavioural and physiological factors and the results discussed in light of the theoretical frameworks outlined.

CHAPTER 3. Animal-assisted interventions in the classroom – a systematic review

In order to inform the research question 'Investigating the effects of Animal -Assisted-Intervention on typically developing children in the educational setting: what works?', the current review will focus specifically on animal-assisted interventions which have been carried out within the classroom setting. It will summarise existing research and compare specific details of the studies to build a coherent picture of animal interventions within educational settings at this current time. Findings will be discussed in order to inform this research and future working practice with animals in the classroom.

3.1 Method

3.1.1 Protocol

This systematic literature review is reported in accordance with PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) and the PRISMA checklist (Liberati et al., 2009). PRISMA provides an evidence-based minimum set of items for reporting in systematic reviews through a 27-item checklist.

3.1.2 Eligibility

Search methods, eligibility and exclusion criteria were specified in advance of the review taking place. The following eligibility criteria were applied:

A) All studies had to be conducted in formal educational settings involving children and adolescents from 2;6 to 18;0 years. This incorporates formal early years' settings and schools. Studies were eligible if they:

   a. Incorporated a real dog/s within the study design,

   b. Reported any cohort size, including case studies

B) Only studies reporting empirical research findings were included

C) Only research published in peer-reviewed journals was included.

Dissertations and post-graduate theses were included as part of a grey literature search. As these were not necessarily published, they would not meet criteria 'C' above; in all other respects, they were expected to meet the eligibility criteria to be included in the review.

3.1.3 Information sources

A total of nine databases were searched from their start date to present for peer-reviewed articles. These included Academic Search Complete (1965 – present), Child Development & Adolescent Studies (1927 - present), Frontiers in Science (2002 – present), Medline (1946 - present), PyschArticles (1894 - present), PsychInfo (1967-present), Science Direct (1946- present), Scopus (2005 - present), Taylor & Francis online (including Anthrozoös, Childhood Education and Educational Review Journals) (1990 - present) and Web of Science (including Web of Knowledge) (1970 – present).

Additional literature was searched using three websites dedicated to the study of human animal interactions: WALTHAM Science (https://www.waltham.com/waltham-research/hai-research/hai-resources/), HABRI-Central (https://habricentral.org/resources/) and Animals and Society Institute (https://www.animalsandsociety.org/human-animal-studies/society-and-animals-journal/).

Additionally, two databases were also searched for grey literature: ProQuest Dissertations & Theses Global, and System for Information on Grey Literature in Europe http://www.opengrey.eu/).

3.2 Search strategy

Search terms were combined with relevant keywords: “Animal-assisted intervention”, “Canine-assisted intervention”, “Dog-assisted intervention” combined with “children”, “education”, “school”, “classroom”, “learning” “autism” or “reading”.

3.3 Study Selection

The first author conducted an initial search of databases in February 2016. A further search was conducted in February 2017 to ensure all new material was included within the review. Titles were scrutinised to ensure they related directly to the topic of review. Articles were then screened through the abstract to ensure they fitted the eligibility criteria. Papers deemed valid to the review were then systemically searched to obtain specific information required for the analysis to take place. In addition to authorship information, further information was extracted in relation to demographics (cohort size, age, gender, characteristics such as learning disabilities, formal diagnoses), methodology (control type, type of animal, experimental tasks, timing of intervention), measures collected (e.g. cognitive, behavioural, physiological, ethological) and animal welfare and ethical issues (length of animal contact time, training level/certification of dogs, allergy information, risk assessment, ethics). The analysis of the review was undertaken using this information (see Fig 1).

3.4 Results

The search returned 841 articles. A large proportion of the articles excluded at this stage were related to assisted education and educational interventions, but did not include animals within the classroom. Many of the published articles returned in the search did include animal interventions, but did not necessarily take place within the educational setting and were also excluded. This left 167 remaining papers, duplicates were removed (N = 125) leaving 42 research papers for review. The remaining 42 articles were subjected to additional scrutiny to ensure they fit the eligibility criteria. A further 17 papers were removed: six were not included due to being systematic literature reviews, nine were general articles related to animal-assisted therapy rather than empirical research publications and two related to theoretical models of the application of animal-assisted therapy. There were 25 eligible articles remaining for review.

These 25 articles are reports of empirical research carried out with children and adolescents in educational settings and involved three different animals: three involved the use of guinea pigs, one included a rabbit and the remaining twenty-one included the assistance of a dog. Of these, 16 studies related to research carried out with school-aged children in an educational environment and eight to research carried out with pre-school (or kindergarten) children in nursery settings, one study spanned both age ranges.

Studies included intervention with typically developing children, in addition to emotional and behavioural disabilities, Downs Syndrome, Autism Spectrum Disorder, including Asperger's Syndrome, oppositional defiance disorder, attention deficit disorder with hyperactivity, reactive attachment disorder, intermittent explosive disorder, central auditory processing disorder, visual processing challenge, auditory processing challenge and attention focus challenge listed as diagnoses within the publications.

The focus of investigation across many of the studies was largely socio-emotional, including the effect of animals on mood, emotional regulation, and social behaviours and functioning. Other topic areas included the effect of animals in the classroom on: insecurely/disorganised attachment behaviours; reading rate, accuracy and comprehension; adherence to instructions and instructional prompts; categorisation and object recognition; motor tasks, and lastly general classroom behaviour.

To facilitate discussion of the papers in this review, the studies are grouped and reported based on the topic of investigation in the first instance, and will be followed by wider discussion which presents a critical overview of the research as a conclusion to the review. Statistics will be presented where possible depending on whether they were reported in the articles.

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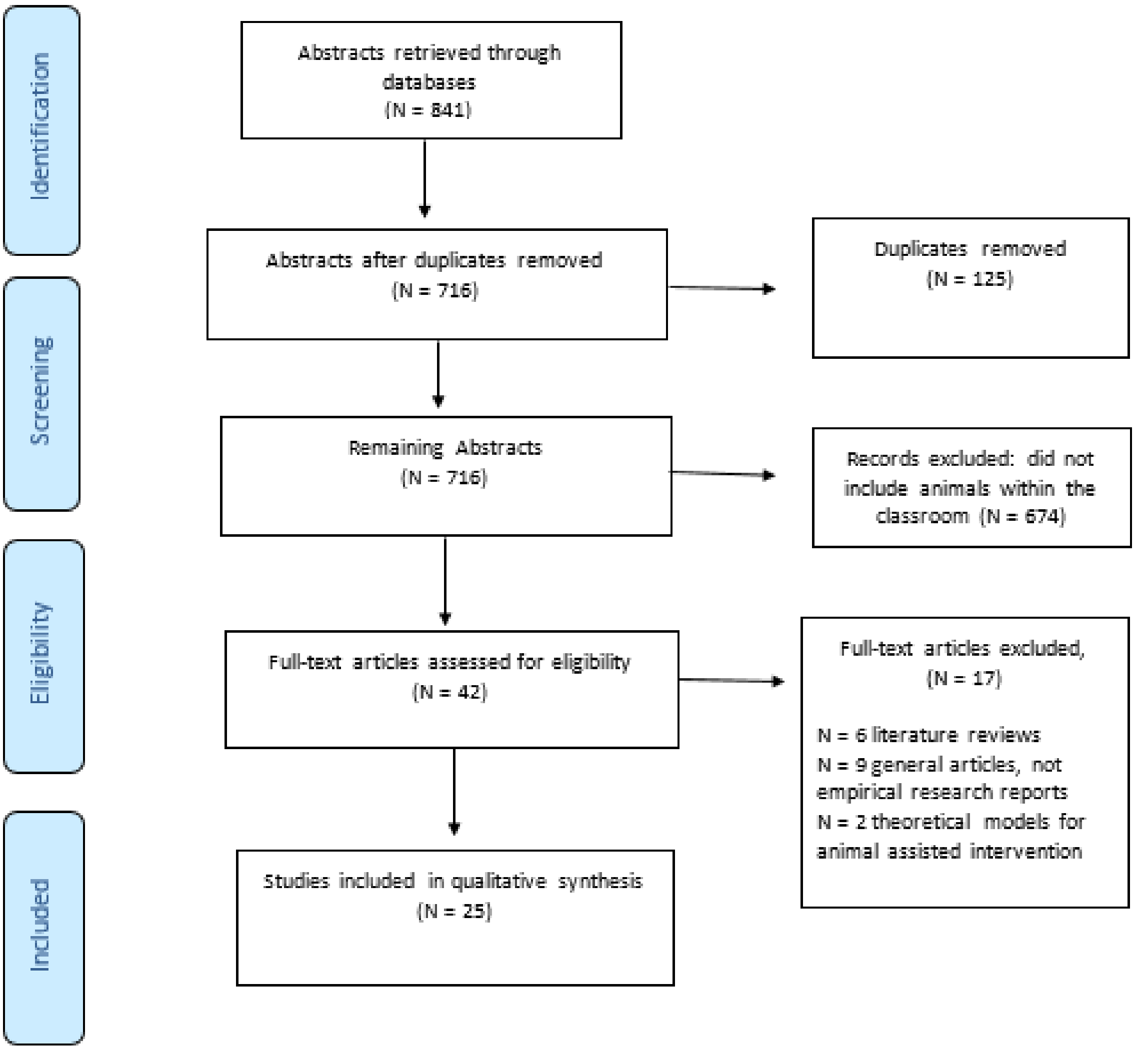

Figure 3: Flow chart of selection and eligibility criteria in the systematic review. Flow chart adapted from PRISMA (Moher, Liberati, Tetzlaff, Altman & The PRISMA Group, 2009).

The Oxford Centre for Evidence-based Medicine (OCEBM) Levels of Evidence (2011) were applied to the remaining articles. Articles were grouped by first and second authors independently and agreement reached on any differences. N.B: The levels are not intended to provide a definitive judgment on the quality of evidence (see OCEBM Introductory document, Howick et al., 2011).

Table 1
Levels of evidence for articles within systematic review (as defined by OCEBM)

Level	Levels of Evidence	Quantity of articles
1	Systematic reviews of randomised trials or n – 1 trials	N/A
2	Randomised trial or observation study with dramatic effect	21
3	Non-randomised controlled cohort/follow-up study	0
4	Case series, case-control studies or historically controlled studies	4
5	Mechanism based reasoning	0

Table 2.
Overview of eligible studies included within systematic review

First Author	OCEBM rating	Participants				Type of control group within study	Animal	Experimental task during intervention
		Group size (N)	**Age**	**Gender**	**Cohort behavioural/learning difficulties in addition to TD cohort**			
Beetz 2013	2	46	8 - 9yrs	M = 23, F = 23	None	Independent class control	Dog	None
Donaldson 2016	2	47	3;8 – 4;11yrs	M = 23, F = 24	Developmental delay/disability (N = 4)	Independent class control	Dog	Emotional matching task
Gee 2007	2	14	4 - 6yrs	M = 10, F = 4	‘identified' pre-schoolers having learning deficits, behaviour deficits, underdeveloped social skills as assessed by independent committee for preschool education	Each child took part in both conditions and acts as their own control	Dog	Gross motor skill tasks
Gee 20	2	11	3 - 5yrs	M = 8, F = 3	‘identified' pre-schoolers having learning deficits, behaviour deficits, underdeveloped social skills as assessed by independent committee for preschool education	Child acts as own control: Dog, stuffed dog, human & no co-performer	Dog	Motor skills
Gee 2010a	2	12	3 - 5yrs	M = 7, F = 5	‘identified' child has delays in the following areas, cognitive, speech & language or pragmatic skills	Child acts as own control: Dog, stuffed dog, human & no co-performer	Dog	Object categorisation task
Gee 2010b	2	12	3 - 5yrs	M = 6, F = 6	‘identified' child has one or more difficulties with oral expression, basic reading skills, listening comprehension, written expression.	Child acts as own control: Dog, stuffed dog, human & no co-performer	Dog	Memory Task
Gee 2012a	2	20	2 - 5yrs	M = 11, F = 9	‘identified' child has one or more difficulties with oral expression, basic reading skills, listening comprehension, written expression.	Child acts as own control: Dog collaborator, human collaborator	Dog	Object recognition performance

Table 2.
Overview of eligible studies included within systematic review

First Author	OCEBM rating	Participants				Type of control group within study	Animal	Experimental task during intervention
		Group size (N)	**Age**	**Gender**	**Cohort behavioural/learning difficulties in addition to TD cohort**			
Gee 2012b	2	17	3 - 5yrs	M = 7, F = 10	‘identified' child has one or more difficulties with oral expression, basic reading skills, listening comprehension, written expression.	Child acts as own control: Dog collaborator, stuffed dog collaborator human collaborator	Dog	Object categorisation
Hergovich 2002	2	46	6 - 7yrs	M = 23, F = 23	Viennese first grade classes at European School, Families of economic migrants	Control class with no dog	Dog	None
Kirnan 2016	2	169	Kindergarten to 10yrs	M = 85, F = 84	Students in traditional and special educational needs classrooms – not specified further, Mix of Caucasian, Asian, Hawaiian/Pacific Islander, Hispanic, and Other/Multi-racial.	MAP scores (reading) used as control for dog group in following year.	Dog	Reading task
Kogan 1999	4	2	11 & 12yrs	M = 2	Child A: mild retardation, attention deficit disorder, oppositional defiant disorder, depression and explosive tendencies. Child B: hyperactive, depression & problems with impulse control Both had Emotional disorders	None: case study	Dog	None
Kotrschal 2003	2	24	6 - 7yrs	M = 14, F = 10	First generation immigrant families in mainstream class	Class acts as own control group – was video taped for a month before intervention	Dog	None
Le Roux 2014	2	102	7 - 13yrs	Not stated	Poor readers (as assessed by ESSI)	Randomised control: Dog, adult and teddy groups	Dog	Reading program

Table 2.
Overview of eligible studies included within systematic review

First Author	OCEBM Rating	Participants				Type of control group within study	Animal	Experimental task during intervention
		Group size (N)	Age	Gender	Cohort behavioural/learning difficulties in addition to TD cohort			
Loukaki 2014	4	39	2 - 5yrs	Not stated	None	None	Rabbit	None
O'Haire 2013	2	128	5 - 13yrs	M = 71, F = 57	Included ASD children but not analysed in paper	Child acts as own control	Guinea pigs	Classroom based activities
O'Haire 2014	2	64	5 - 12yrs	M = 50, F = 14	ASD	Child acts as own control	Guinea pigs	Classroom based activities
O'Haire 2015	2	114	5 - 12yrs	M = 60, F = 54	ASD	Child acts as own control: Reading silently (baseline control), scripted classroom activity-reading aloud, free play with peers/toys, free play with peers/toys and G Pigs	Guinea pigs	None
Tissen 2007	2	230	7 - 10yrs	M = 109, F = 121	None	Randomised control: Social training with dogs, social training without dog & dog attendance without training.	Dog	Social training
Treat 2013	2	17	7 – 10yrs	M = 11, F = 6	Identified learning disabilities included: Visual processing challenge, Auditory processing challenge, Attention focus challenge,	Readers with teacher & dog, Readers with teacher and no dog	Dog	None
Wicker 2005	2	31	12;2 – 17;5 yrs	M = 22, F = 9	Emotional difficulty Autistic-like behaviour	Control group without AAT Individual, small group AAT	Dog	None

Table 2.
Overview of eligible studies included within systematic review

First author	Measures					Timing of intervention assessment			
	Cognitive	**Motor**	**Behavioural**	**Physiological**	**Ethological**	**Baseline**	**Immediate start/during**	**Immediately following**	**Long term effects**
Anderson 2006	None	None	Problem solving sheets and ABC analysis forms	None	Daily observations	Yes	No	Yes	Not assessed
Bassette 2013	STAR reading progress	None	Interviews	None	None	yes	Yes	Yes	yes
Becker 2014	Subtests from -WISC-IV -WRAML-2 -NEPSY-II	None	None	GSR – blood pressure and heart rate	None	No	Yes	No	Not assessed
Beetz 2011	None	None	The separation anxiety test (SAT). The questionnaire, "My pet and I" - pet attachment questionnaire. The Trier Social Stress Test for Children (TSST-C) Self-Assessment of Stress (SAM) TSST-C task	Salivary Cortisol collection& analysis:	Video behaviour of all sessions	Yes	Yes	Yes	Not assessed
Beetz 2012	None	None	The separation anxiety test (SAT) The questionnaire, The Trier Social Stress Test for Children (TSST-C) Self-Assessment of Stress (SAM) TSST-C task	Salivary Cortisol collection& analysis:	Video behaviour of all sessions	Yes	Yes	Yes	Not assessed
Beetz 2013	None	None	Depression scale for children Emotional & Social experiences in school questionnaire (FEESS 3-4) Emotional regulation in children and juveniles (FEEL-KJ). NEO personality questionnaire	None	None	No	Yes	yes	Not assessed

Table 2.
Overview of eligible studies included within systematic review

First author	Measures					Timing of Intervention Assessment			
	Cognitive	**Motor**	**Behavioural**	**Physiological**	**Ethological**	**Baseline**	**Immediate start/during**	**Immediately following**	**Long term effects**
Donaldson 2016	None	None	Strengths and difficulties questionnaire (SDQ)	None	Video behaviour of certain sessions	Yes	Yes	Yes	Not assessed
Gee 2007	None	Experimental task	None	None	Video recorded	N/A	N/A	Yes	Not assessed
Gee 2009	None	Experimental task	None	None	Video recorded	N/A	N/A	Yes	Not assessed
Gee 2010a	Experimental task	None	None	None	Video recorded	N/A	N/A	Yes	Not assessed
Gee 2010b	Experimental task	None	None	None	Video recorded	N/A	N/A	yes	Not assessed
Gee 2012a	Experimental task	None	None	None	Video recorded	N/A	N/A	Yes	Not assessed
Gee 2012b	Experimental task	None	None	None	Video recorded	N/A	N/A	yes	Not assessed
Hergovich 2002	Coloured progressive matrices (CPM) Children's version of Gestalt Perception Test Development Test (measure of social intelligence)	None	Teachers' assessments of pupil's sociability, social integration & aggressive behaviour. Self-assessment of empathy with animals (Killian, 1994)	None	None	yes	Yes	No	Not assessed
Kirnan 2016	None	None	None	None	None	No	No	Yes	Not assessed

Table 2.
Overview of eligible studies included within systematic review

First author	Measures					Timing of Intervention Assessment			
	Cognitive	**Motor**	**Behavioural**	**Physiological**	**Ethological**	**Baseline**	**Immediate start/during**	**Immediately following**	**Long term effects**
Kogan 1999	None	None	ADD-H comprehensive teacher rating scale, Personal IEPs, post intervention interviews	None	Video: Direct obs & daily coded video	Yes	N/A	Yes	Not assessed
Kotrschal 2003	None	None	yes	None	Video recorded	Yes	Yes	No	Not assessed
Le Roux 2014	Neal analysis of reading ability (1999)	None	None	None	None	Yes	No	Yes	yes
Loukaki 2014	None	None	In house questions: socialisation, communication & emotional expression	None	None	none stated	none stated	none stated	none stated
O'Haire 2013	None	None	Social skills rating system (SSRS); subsets Social skills, Problem behaviours, Academic competence	None	None	Yes	No	Yes	Not assessed
O'Haire 2014	None	None	Pervasive developmental disorder behaviour inventory (PDDBI) teacher/parent assessment - short version, Social skills rating scale (SSRS)	None	None	yes	No	Yes	Not assessed
O'Haire 2015	None	None	Social communication Questionnaire (SCQ). Social skills rating system (SSRS), Social worries Questionnaire (SWQ), Character description by parent & teacher rating Emotional valence- children rated how they felt.	Skin conductance measures, inc. temperature	None	Yes	Yes	No	Not assessed

Table 2.
Overview of eligible studies included within systematic review

First Author	Measures					Timing of Intervention Assessment			
	Cognitive	**Motor**	**Behavioural**	**Physiological**	**Ethological**	**Baseline**	**Immediate start/during**	**Immediately following**	**Long term effects**
Tissen 2007	None	None	Inventory for the Assessment of Impulsivity, Risk Behaviour and Empathy. Social behaviour (assessment for teachers, 1981). Bully/Victim-Questionnaire (Olweus 1989)	None	None	yes	Yes	Yes	yes
Treat 2013	-Gray Oral Reading Test (GORT-$) -Basic Reading Inventory (BRI)	None	Reader Self-Perception Scale (RSPC) Basic Reading Inventory (BRI) Anxiety measure made in house by researcher	None	None	Yes		Yes	Not assessed
Wicker 2005	None	None	Behaviour Assessment System for Children BASC) Teacher Rating Scale – Adolescent form(TRS-A) Self-report of Personality - Adolescent form (SRP-A)	None	None	Yes		Yes	Not assessed

Table 2.
Overview of eligible studies included within systematic review

First author	Animal Welfare		Approximate length of contact				
	Animal Contact Hours	**Type of contact**	**weekly**	**monthly**	**length and total hrs**	**Training level of animal**	**Risk and ethical considerations**
Anderson 2006	Dog in class	8am - 3pm per day for 8 weeks (except 1 day for illness)	30hrs week	x 8 = 240hrs	2 months = 240hrs	**Not** trained therapy dog Not trained to interact for the intervention. Dog not previously experienced younger children	Ethics board Protocol for ensuring safety in classroom whilst dog roaming. Allergies to dogs thro parent interview Children taught safe contact behaviours i.e. not touching dog whilst it ate, slept etc.
Bassette 2013	30mins per day x 4wks	Dog sat next to child	2.5hrs week	x 4 = 10hrs	I month = 10 hrs	Trained therapy dogs	Ethics board Children included who were not fearful or allergic to dogs
Becker 2014	30 mins per child in room whilst doing experimental task	25mins dog in room 3mins direct interaction		One-off support		Not trained therapy dog. Owned by school teacher	Approved by university review board and school approved. Consent & allergy information from parent. Children were excluded based on school assessment of inability to interact appropriately with animals (behavioural school)
Beetz 2011	25 mins per child during a full day	free interaction with child as social support	25 mins	one-off support		Trained therapy dogs	None stated
Beetz 2012	25 mins per child during a full day	free interaction with child as social support	25mins	one-off support		Trained therapy dogs or school- dog	None stated
Beetz 2013	1day per week, over year	1 day per week free roaming	6hrs week		Full school year	Experienced school-dog	Ethics board Absence of allergies in the class
Donaldson 2016	9.50-11.10 2 mornings per week over 9 wks	In enrichment area of class – interaction	35mins per child per week	2hrs 20mins	Up to 21 hours	Certified therapy dogs – fully assessed	Ethics and consent in appendices
Gee 2007	Dog had 15 min break within each half hour	Dog performed motor task with children	15 mins	one-off support		Certified therapy dogs	University Institutional Review Board

Table 2.
Overview of eligible studies included within systematic review

First Author	Animal welfare		Approximate length of contact				
	Contact hours	**Type of contact**	**Weekly**	**Monthly**	**Length and total hours**	**Training level of animal**	**Risk and ethical considerations**
Gee 2009	2 dogs - each in school on alternate days. 1 in 4 tasks involved a dog time for rest between	Performed motor task with or before child	15-20mins	one-off support		Certified therapy dogs	University Institutional Review Board
Gee 2010a	30mins per day x 4wks	Sat with child		one-off support		Certified therapy dogs	University Institutional Review Board
Gee 2010b	dog not present every day of testing	Dog present next to child		one-off support		Certified therapy dogs	University Institutional Review Board
Gee 2012a	60 - 90 mins, twice per week	Sat with child	5mins per child - task	one-off support		Certified therapy dogs	Letter for consent sent home to parents University Institutional Review Board
Gee 2012b	60 - 90 mins, twice per week	Sat with child	10mins per child –task	one-off support		Certified therapy dogs	Letter for consent sent home to parents University Institutional Review Board
Hergovich 2002	Dog present in class for 3 months from 8am - 12pm	Free roaming, children allowed to pet the dog	20hrs week	8 hrs	3 months = 240hrs	Trained therapy dogs	Start of study, children taught how to care for a dog e.g pet, feed, give a toy to dog
Kirnan 2016	1 hour per class over 1 academic year	Dog sat with group	1 hour with group		School year	Trained therapy dogs	Schedule drawn up so dogs not overworked working with 5 classes for 1 hours per week. Letter sent home to parents and parental permission obtained
Kogan 1999	Dog with child 45-60mins per week for 12 weeks	General interaction and bonding alongside other tasks	45 - 60mins	3-4hrs	9-12hrs	Human-animal team	None stated
Kotrschal 2003	Dog present in class for one month, children videoed for 2hrs, 3 times per week	Interact with dogs in a respectful manner at any time during their presence	All day	School for full day during one month		L	Worked with school to overcome bureaucratic hurdles Boundaries set with children at start of project to instruct about dog's needs, care & handling

Table 2.
Overview of eligible studies included within systematic review

First Author	Animal welfare		Approximate length of contact				
	Contact hours	Type of contact	Weekly	Monthly	Length and total hours	Training level of animal	Risk and ethical considerations
Le Roux 2014	Dog reading 20mins	Dog sat with child-child read to the	20 mins per week	1hr 20 mins	2.5months = 3hr20mins	Trained therapy dogs	Ethics board None of children taking part were allergic to dogs
Loukaki 2014	In a transparent box in classroom twice per week for 2 hours for 6 months	General	4hrs week	16 hours	96 hours	None mentioned	None stated
O'Haire 2013	5-6 hours per day over 8 weeks	Responsibility for feeding, grooming and general care for the Guinea pigs.	25hrs week	G Pig in class all day for 2 months		Consideration for type of animal partly based on child safety	Ethics board
O'Haire 2014	5-6 hours per day over 8 weeks	Responsibility for feeding, grooming and general care for the Guinea pigs.	25hrs week	G Pig in class all day for 2 months		Consideration for type of animal partly based on child safety	Ethics board
O'Haire 2015	2 x 20min sessions per week, over 8wk intervention	Free play	40mins	2hrs 40 mins	2months = 5hrs 20mins	Consideration for type of animal partly based on child safety	None stated
Tissen 2007	90mins per week over 10 weeks	Children interacted with dog as part of the social task	90mins week	6hrs	2.5months = 15hrs	Trained therapy dogs	None stated
Treat 2013	10-15mins varied 1-3 times per child, per week	Guided reading with dog and teacher/researcher	10-15min x 3 30-45 mins	Varied	2 -2hrs 30 mins max	Trained therapy dog	States certified therapy dog
Wicker 2005	1 to 1 = 1hr per week Group = 2 x 1 hr per week 10 weeks	Training dog and learning about dog	1 to 1 = 1hr Group = 2 x1 hr	1 to 1 - 4hrs Group – 8hrs	10 weeks 1to1 =10hrs Group = 80hrs	Trained dog handler Dogs from community members	Not certified dog parental permission sought

3.4.1 Reading ability

The search returned four relevant studies that met our criteria (for a review on children reading with dogs, including broader criteria see Hall et al., 2016). These four studies involved the use of reading programs combined with canine intervention in kindergarten and school-aged children. All studies were carried out in educational settings, however, because they included distinctly different populations of children and differing study designs, direct comparison of the outcomes across these studies is difficult. Bassette and Taber-Doughty (2013) used a single case design of pupils (N=3) with emotional and behavioural difficulties, aged 7 years (N=1) and 11 years (N=2) and assessed ‘on task behaviours’ through a multiple probe technique. Le Roux, Swartz and Swartz (2013) included typically developing children who had been identified as poor readers and were between the ages of 7 -13 years (N=102) in their randomized controlled trial which assessed the effect of dogs’ presence on reading rate, accuracy and comprehension. In contrast, both Kirnan, Siminerio and Wong (2016) and Treat (2013) included larger cohorts whose ages spanned across a range of year groups. Kirnan et al. (2016) investigated a cohort which ranged from kindergarten to Grade 4 pupils (9 -10 years, N = 169), some in “traditional classrooms”, others in special education classrooms (although numbers are not specified). Treat’s (2013) study involved children with specific learning disabilities and spanned across year groups from 2nd and 5th Grade (7 -11 years). Children took part in guided reading aloud sessions with or without a dog.

Bassette and Taber-Doughty (2013) investigated three pupils’ educational engagement whilst reading in the presence of a dog. On-task behaviour was measured using Interval Recording (Alberto & Troutman, 2006), a type of Applied Behavioural Analysis (ABA) observational record of whether a behaviour occurs during intervals of a specified time period. The accelerated reader (AR) quiz program (an internal daily school reading assessment) was used to assess reading comprehension. Each child read individually for half an hour per morning in the presence of a dog for a period of 4 weeks. Children were assessed on their reading comprehension and on-task reading aloud behaviour prior to and following intervention. After one month, children were assessed on the maintenance of on-task behaviours without a dog present. The authors describe percent of intervals on-task reading aloud and state a moderate to significant improvement of ‘on-task’ behaviours. Despite using the AR program, results are not presented in the result section and seem inconclusive. Teachers also completed a Social Validity Interview and reported improvements in behaviour during intervention. No standardised measures were completed as part of the evaluation. Given the above weaknesses in assessment and analysis, it is hard to draw conclusions from this study.

Le Roux et al. (2013) evaluated the effect of the presence of a dog on children’s reading ability using a pre-post-test design with control group. They addressed the potential confound of single dog and single handler by employing several dogs and handlers. All dogs were trained therapy dogs, all dog handlers were trained and received additional training on the task. Familiarisation was carried out for all groups before testing. For assessment, the Reading Educational Assistance Dogs program (READ) was used, and three further conditions were included: reading to a human or a teddy bear, and control group with no intervention. Children were randomly assigned into test groups and read to the human, dog or teddy for 20 minutes per week over a 10-week intervention period. Reading was assessed using the Neale Analysis of Reading Ability before the intervention, directly after 10 weeks and again 8 weeks later. The main effect for group was significant [F (3,94) = 3.40, p = 0.2, η^2 = 0.9] with dog group (M = 7.94, SD = 0.96) demonstrating a higher reading rate than the teddy bear group (M= 7.45, SD = 7.9) and significantly higher reading accuracy than all other groups. A significant main effect was also found for reading comprehension age scores [F (3, 94) = 5.02, p = .02, η2 = .15] with the dog group showing significantly higher comprehension scores than all other groups. The authors report that eight weeks after the completion of the reading program, students in the ‘dog group’ retained their lead over the students in the other three groups. However, reading comprehension was the main ability retained by students in the dog group; not all reading skills were maintained after the 10-week intervention. Both Bassette and Taber-Doughty (2013 and le Roux et al. (2013) conclude that animal intervention has a role to play in academic engagement and reading skill. Both studies also acknowledge that further work is needed to tease apart the factors involved, for example, immediate improvement in measures followed by high variability may be due to initial motivational factors. The presence of a dog may improve reading by affecting physiological measures such as blood pressure. It is also possible that effects are due to the dog or the individual present during intervention, including the bonding process.

Kirnan et al. (2016) assessed the effect of a therapy dog on the reading skills of children across a whole school cohort from Kindergarten to 4th Grade. Children in “traditional” classes typically read to the dog in groups of 4 -6 whilst children in special education classes read to the dogs individually; dogs attended each class for approximately one hour per week. Children also took part in a writing component such as writing dog themed articles or journals. Kindergarten and 1st Grade children experienced a more integrated dog program through a language arts curriculum which included writing about dogs, illustrating writing, and playing vocabulary games based around a dog theme. Reading scores were assessed mid- year (Winter-scores) prior to intervention, and at year-end (Spring scores) through school Measures of Academic Progress (MAP). MAP scores from a previous cohort of children (2010/11) were used as a control measure to compare reading scores to those in the dog group (2011/12). The analyses found a statistically significant difference in kindergarten with the dog reading group ending the year with significantly higher reading scores than the control group (control (M = 160.34, SD = 11.97), dog (M = 169.96, SD

=10.04), ($t = 3.35$, $p > 0.001$). No other year group demonstrated significant differences in reading scores between dog and control conditions. The authors acknowledge that using the previous academic years' performance as a control is problematic and reading score gains could be influenced by cohort differences or historical events. Indeed, factors such as classroom environment, the effect of a different teacher, and the dynamics of the class as a whole cannot be controlled for and so their impact is unknown. There is also an assumption on the part of the researcher that all year groups are performing at the same level year on year, in reality this may not be the case, certain year groups of children may perform worse or better than others.

Treat (2013) assessed the effect of a certified therapy dog on the reading abilities of 17 children (male N = 11, female N = 6) who had identified learning disabilities, stated as visual processing challenge, auditory processing challenge and attention focus challenge. The intervention involved each child taking part in guided reading aloud with a teacher/researcher. Children were assigned to either a dog or no dog group. Reading sessions lasted 10-15 minutes (depending on story length) and took place 1 to 3 times per week depending on availability of the child. Each child had 10 sessions of intervention. Interventions also involved the child receiving instruction and feedback on strategies to assist with their reading comprehension and fluency during the sessions. Only the dog group was assessed pre- and post-intervention using the Gray Oral Reading Test (GORT-4). Both groups were assessed pre- and post-intervention using the Basic Reading Inventory (BRI) and the Reader Self-Perception Scale (RSPS). The latter was used to gauge perceived self-efficacy in reading upon completion of the intervention. An anxiety measure was also completed, although this was a questionnaire devised by the researcher and not a standardised tool. The study demonstrated significant improvement between pre- and post-test scores on the GORT-4 for reading rate, accuracy, fluency, comprehension and reading quotient in the dog group. The comparison group was not subjected to the GORT-4 pre-post assessment due to lack of time, leaving open the specific effect of the dog during the reading sessions. The other two measures show improvement before and after intervention, however, only descriptive data is provided, no statistical analysis was employed, therefore it is unclear if the differences are statistically or clinically significant.

The study acknowledged, but failed to control for the fact that some of the children had already been receiving part of the intervention strategy implemented by the teacher for a year before the study commenced. This is problematic as it remains unclear if any effects observed where due to the intervention applied during the research period. Further analysis of those children who had already been receiving part of the intervention strategy previously could have clarified this issue and answered this question.

3.4.2 Emotional stability and learning

Four of the papers within the review focused on the improvement of the socio-emotional wellbeing of pupils, all involved the presence of a dog and all looked at the impact of the outcomes on the potential to support learning in the classroom environment. Two of the studies used a case study design (Anderson & Olson, 2006; Kogan, Granger, Fitchett, Helmer and Young., 1999), and two involved a larger group of children (Beetz, 2013, Donaldson, 2016).

Anderson and Olson (2006) used a case study design to investigate the effect of the presence of a dog on the emotional stability and learning of students with a range of severe emotional disabilities, including oppositional defiant disorder, attention deficit disorder with hyperactivity, reactive attachment disorder, intermittent explosive disorder, central auditory processing disorder, mood disorder, bipolar disorder, and Asperger's Syndrome. The sample included six children aged 6 – 11 years who had been unsuccessful in the mainstream school environment and who were placed in a self-contained classroom accompanied by one-to-one tutors. Children were observed and their behaviour documented for 8 weeks, then the intervention took place over an 8-week period with the dog present in class each day between 8am and 3pm with the same observation and documentation. Each child took part in one-to-one sessions for thirty minutes every day. Children also interacted with the dog throughout the school day, socialising with the dog during educational activities such as reading and playing with the dog during break-times. The dog was not a trained therapy dog and had limited experience with children, but the authors put risk-reducing strategies in place. Both qualitative and quantitative data were collected, including parent and teacher reports before and after intervention through Problem Solving Sheets and ABC analysis forms. ABC Problem solving sheets were completed when the child entered emotional-crisis. Sheets allowed the recording of Antecedents (A) events that preceded the crisis, Behaviour (B) observed behaviour, and Consequences (C) consequences and events following crisis. No standardised measures were collected. No separate control group was tested. The authors collected observational data, interview data with the children and their parent. They used qualitative analysis and reported that the dog contributed to the children's overall emotional stability, improved behavioural control and students' attitudes towards school and facilitated the students learning in relation to responsibility, respect and empathy. Overall, the dogs had positive socio-emotional effects on the students. The presence of the dog in class for the whole of the 8-week period during the day makes it difficult to discern the potential advantage to the children of the one-to-one sessions with the dog and demonstrate whether the mere presence of the dog in the classroom without personal intervention with each child may had still had the same effect. A further concern relates to the potential bias in interpretation of the results obtained by the teacher/researcher. The authors acknowledge that "the lack of negative findings" (p. 47) could be questioned as an effect of teacher expectations, a comparison condition within the design of the study would have controlled for this potential bias.

Kogan, Granger, Fitchett, Helmer and Young (1999) also used a case study design with two male children. Child A was 11yrs old and was diagnosed as having mild intellectual disability disorder, attention deficit disorder, oppositional defiant disorder, depression and explosive tendencies. Child B was 12 years old and described as hyperactive, having depression and problems with impulse control. Both children were identified as emotionally disturbed. Each child took part in weekly sessions of between 45- 60 minutes with a therapy dog. Sessions consisted of two parts: rapport-building time and animal time. Children could interact with the dog, including activities such as petting or brushing the dog as well as discussing previous positive and negative events with the handler. Goals were set by the Special Educational Needs teacher to work on during the AAI sessions. Standardised Teacher Social Skills rating scales were completed before and after intervention. Individual Education Plans were assessed, all sessions were videotaped and post-intervention interviews with children, families and educational professionals were carried out. Positive results were reported for both case studies, with Child A demonstrating a reduction in negative verbal statements and increased positive ones. These positive communication skills transferred into daily activities during interaction with others, such as an improved voice tone and increased patience when dealing with peers. Child B showed noticeable improvements across learned helplessness, with his sense of control of himself and his environment improving dramatically. Working closely with the dog was reported to have had a direct influence on their sense of control by decreasing feelings of helplessness and improving self-confidence. The study focused on goal-setting and regulation of behaviours during intervention with the authors asserting that both children improved on most of their goals after intervention with a dog. It is difficult to assess the direct beneficial effect of the dog alone as the intervention consisted of a human-dog team.

In contrast, Beetz (2013) assesses the intervention of a ‘school dog-teacher-team’ together on the social interactions of children within the classroom. The study consisted of children between the ages of 8 to 9 years (N = 46) with equal numbers of both male and female (N = 23); dog cohort age (M = 8.5, SD = .51) and control cohort age (M = 8.4, SD = .51). Two cohorts were used: one classroom was visited by a dog for one day per week over the course of a year, a further class with no dog served as the control. The study involved a comprehensive battery of standardised questionnaires assessing the socio-emotional well-being of the children before the intervention began and again following intervention. Depression scores did not differ across time as a result of intervention in either the dog or control condition, however, positive attitude towards school and positive emotions towards learning) as measured by the FEESS 3-4 (Questionnaire on Emotional and Social experiences in school, Grade 3-4) rated significantly higher in the dog group than the control no-dog group. The researchers reported a medium to strong effect of benefit to the whole class as a group. Worryingly, the no-dog group demonstrated a decrease in their attitudes towards school and emotions towards. The authors point out that the third year for students in Germany is a time of high academic pressure and the dog may have acted as a buffer during this stressful period in which the control class did not have access to a dog.

This could add to the argument of the beneficial effect of the dog in the classroom, however, it is also possible that the children in the no-dog-class were aware that while the other classroom had a dog, their classroom did not. This awareness could be responsible for the decreased attitudes towards school and emotions towards learning found in the no-dog group.

Lastly, Donaldson (2016) investigated the use of a therapy dog to promote empathy in pre-school classes. The study involved N=47 children aged 3;8 – 4;11years, male (N = 23), female (N = 24) and a PAWS trained therapy dog and their handler were involved. Three classes were used as condition groups (no random assignment); one with a therapy dog, one with a plush toy dog, and one control group with no additional adjunct. It is important to note that, as in the above studies, intervention is confounded with classroom/teacher/students.

Children were assessed using the Emotion Matching Task (EMT) and two scores from the Strengths and Difficulties Questionnaire (SDQ). Video footage was also collected in the dramatic play area, this was analysed for prosocial, aggressive and isolation behaviours. Children in the toy and real dog conditions did not improve in emotional recognition over the course of the intervention. Equally, prosocial and difficulty scores from the SDQ failed to demonstrate significant improvement. While some of the qualitative data suggested improvements in children's behaviour, no discernible differences were observed in relation to prosocial, aggressive or isolation behaviours coded from video data. While the previous three studies reported positive emotional effects and the potential of animal-assisted intervention to support learning and educational goals, Donaldson (2016) found no significant effects of the dog condition over others. Importantly, the researchers concluded that the factors involved need quantifying, with two of the papers acknowledging confounding factors, for example, the difficulty in controlling for wider factors, such as teachers, classroom environment and other intervention programs which individual children may already be receiving (Beetz, 2013, Anderson & Olson, 2006).

3.4.3 Social functioning and interpersonal skills

Four of the studies identified in the review investigate the effect of animals on social functioning in the classroom. O'Haire, McKenzie, McCune and Slaughter (2013; 2014) included guinea pigs as the animal of choice in their studies, whilst Tissen, Hergovich and Spiel (2007) and Wicker (2005) involved dogs in their studies.

The first two studies with guinea pigs in the classroom environment aimed to investigate the social functioning of children (O'Haire et al., 2013; 2014). Importantly, the authors highlight that the aim of the research was to examine the impact of the intervention on the functioning of the children within the classroom, as opposed to the specific role of the animal involved.

Their study constitutes two papers; one (2013) reporting the results of the study with typically developing children (N = 128) aged 4.8 – 12.7 years and the other (2014) reporting the results of the effect on children with Autism Spectrum Disorder (N = 64) aged 5.2 – 12.8 years old. Guinea pigs were placed in classroom settings and the children assigned to either an Animal-Assisted Activity group (AAA) group or a waitlist control group. All children received general exposure to the guinea pigs in the classroom setting, the experimental group received in addition separate AAA interaction sessions. AAA sessions were carried out in triads with two typically developing children, and one with ASD taking part in intervention activities for 20 minutes, twice per week over an 8-week period. The activities carried out during the intervention sessions were led by pupil preferences and included a wide range of activities such as feeding, designing experiments, grooming, visual art and circle time. Standardised tests were used to assess the children's behaviour. These included the Pervasive Developmental Disorder Behaviour Inventory (PDDBI) and Social Skills Rating Scale (SSRS) which included parent and teacher assessments of whether children showed changes in their interest in attending school. Information relating to the child's school, teacher, academic grade, pet ownership and outside treatment were also collected.

The authors report that pupils with ASD displayed more social approach behaviours and less social withdrawal following AAA as reported by both teachers ($p < 0.001$) and parents ($p < 0.007$). Participants were also rated as more socially skilled by teachers ($p < 0.008$) and parents ($p < 0.006$). However, problem behaviours showed no improvement following AAA (O'Haire, 2014). Typically developing pupils were also reported to have benefitted from the AAA, with pupils showing significantly greater increases in social skills as rated by teachers ($p < 0.001$) and significantly greater decreases in problem behaviours as rated by both teachers ($p < 0.001$) and parents ($p = 0.003$). Both studies included standardised measures, however, both these measures rely on teacher and parent feedback who were not blind to the conditions and so results are open to expectation bias. Academic competence of the typically developing children (O'Haire, 2013) was also rated by teachers through the SSRS. The study used a waitlist control condition and whilst this is often rated as superior to a no control design, it is not without drawbacks. It is impossible to know whether the wait list condition was potentially negatively affected by motivational factors and an alternative control group may be more useful.

Tissen, Hergovish and Spiel (2007) investigated social behaviour, empathy and aggression in their study with children (N = 230) aged 7 - 10 years old. They investigated the effect of social training programs using six therapy dogs and their handlers. Children's school classes were randomly assigned to conditions as follows: social training without dogs, social training with dogs, and dog attendance without social training. They implemented a 10-week program with 90-minutes of intervention per week in the classroom setting. Standardised questionnaires were carried out with teachers and children before and after interventions and again 3 weeks later with children only. These include the Social Behaviour Scale: Assessment aids for teachers, the Inventory for the Assessment of Impulsivity, Risk Behaviour and Empathy (for children) and a Bully/Victim-Questionnaire for children. The authors report a minor significant effect in social behaviour from the teachers' perspective after the 10-week intervention compared with the start ($p < 0.05$). Measures of empathy also showed a ‘low but significant’ effect ($p < 0.05$). Neither of these were not maintained beyond the intervention. The authors found only in the condition “Social training with dogs” a reduction in open and relational aggression and effects lasted beyond the intervention time. No main effects for condition were found. Hence, it would therefore appear that the presence of a dog can potentially have the same effect as social training and vice versa. Unfortunately, the lack of a no intervention control does not allow the results to be assessed further as all children are either exposed to a dog or social training. The authors acknowledge this and suggest further improvements to their study.

Wicker (2005) investigated the effects of animal-assisted therapy with dogs on the social behaviour and interpersonal skills of N=31 at-risk adolescents aged 12;2 to 17;5 years (female, N = 9, male N = 22) attending alternative public schools. Two of the 6 children were classed as having emotional difficulty and one “ASD-like” (p.38) behaviour. Students in the intervention group (N = 20) had an intervention incorporated into their educational plan. Control students (N =11) were located on a different campus because not enough children consented to take part at the first school. Social skills, aggressive behaviour, attitude to school, interpersonal relations, classroom absences, direction following, acceptance of staff feedback, and respectful responses were measured using a standardized tool (BASC). Students were not randomly assigned to each condition, but were assigned by staff members who saw the child in “critical need of a more intense intervention” (p. 38) into one-to-one sessions for one hour per week. Others were allocated to small groups of five students, twice per week for one hour with the dog.

Students were instructed on how to train and care for the dog. A certified dog trainer was present to oversee sessions. The dogs belonged to members of the community (not the trainer). At the end of the intervention, students demonstrated their dog handling and training skills to the dog owners. The study failed to find any significant effects between the three cohorts in terms of teacher ratings of students' social skills, aggressive behaviour, attitude to school, interpersonal relations and classroom absences, and the authors acknowledge the limitations of their small sample size for analysis. The study provided an insight into the personal experience of those taking part through qualitative information gathered after intervention.

In sum, three of the studies reported benefits of animal intervention in their findings, but equally all three outline the protocol for control group as an area for improvement in future studies to ensure that outcomes can be directly attributable to the intervention, rather than wider factors. Further to this, the importance of gathering more data around participant characteristics such as ability and diagnoses as well as questions concerning scale and amount of interventions will allow researchers in the future to analyse how these individual differences may mediate the intervention under review.

3.4.4 Physiological arousal

Four studies in the review focused on the physiological factors involved during children's interactions with animals in intervention sessions (Beetz, 2011; 2012; O'Haire, et al., 2015, Becker, 2014). Beetz, Kotrschal, Turner, Hediger, Moberg & Julius (2011) carried out an exploratory study involving male children (N = 31) between the ages of 7 and 12 years old, investigating the effects of a real dog, toy dog or friendly person on insecurely/disorganised attached children during a stressful task. Having chosen participants on the basis of preselection using the Separation Anxiety Test (SAT), a series of standardised tests were completed, the Trier Social Stress Test for Children (TSST-C) in combination with Self-Assessment of Stress, The Self-Assessment Manikin (SAM) and a pet attachment questionnaire. Salivary Cortisol was taken at five points throughout the intervention process (T1 to T5). No difference between the three groups was initially found in relation to pet attachment ($F = 0.743$, $p = 0.537$). No significant differences were found for self- reported Activation and Mood (SAM) during or after intervention. Self-reported stress levels did not differ significantly between the groups before or after the stress test (TSST-C), however, cortisol analysis revealed a significantly lower level in the real dog condition ($x^2 = 15.17$, df = 2, $p = 0.001$) (measured under the curve (AUCi). This was also related to the amount of time stroking the dog; more direct contact time resulted in a less pronounced reaction to stress as cortisol was lower at T5 ($r_s = -0.818$, $p = 0.002$).

Further to this, Beetz, Julius, Turner and Kotrschal (2012), investigated the effects of social support by a dog on stress modulation in male children with insecure attachment (N = 47) aged 7 to 11 years. Measures were collected as in the previous study with similar findings that male children with insecure-avoidant/disorganised attachment can profit from the presence of a real dog with cortisol levels at T4 and T5 being significantly lower ($x^2 = 6.17$, df = 2, $p = 0.046$) (measured under the curve (AUCi)) correlating negatively with the amount of physical contact with a real dog (increased stroking resulted in decreased cortisol readings). The more time the child spent stroking the dog before the TSST-C stress test, the greater the drop in cortisol level ($r_s = 0.488$, $p = 0.025$). Again, children's self-reported stress did not correspond with salivary cortisol levels.

O'Haire, McKenzie, Beck and Slaughter (2015) evaluated physiological arousal as a mechanism for observed behavioural changes in the presence of guinea pigs. The cohort (N = 114) consisted of both typically developing children (TD) (N = 76) and children with ASD (N = 36) with a wide age range from 5.1 years to 12.7 years old. The study collected data using a series of standardised questionnaires including the Social Communication Questionnaire (SCQ) (Autism screening), the Social skills rating system (SSRS) (social functioning) and the Social Worries Questionnaire (SWQ). In addition, parent and teacher's ratings of the character of each child were collected and emotional valence rated by children about how they felt after taking part in each condition. The study also collected skin conductance measures, including temperature and motor movement data. Children took part in all four experimental conditions in the same order: baseline reading silently, reading aloud in front of peers for one minute, ten minutes of free play with peers and toys, 10 minutes of free play with two guinea pigs and peers. As expected, significant differences in social anxiety were reported between the TD and ASD cohorts, with participants with ASD scoring significantly higher on the SWQ on both the parent and teacher versions ($p < 0 .001$) demonstrating that children with ASD were perceived as less social, confident and calm than the TD children. No differences in self-rated emotions between the TD and ASD cohort were found. There were differences between the conditions with all children feeling best in the presence of animals compared with toys, reading silently and reading aloud ($p < 0.001$). The presence of animals also resulted in decreased skin conductance in both TD and ASD cohorts. Interestingly, the ASD children displayed greater physiological arousal than TD peers in all conditions, but this trend reversed in the animal condition: animals reduced the general level of arousal and the number of skin conductance peaks in children with ASD compared to the TD children. Conclusions highlight a regulation of physiological stress and a stress buffering effect of the animal on both typically developing and children with ASD.

Lastly, Becker (2014) specifically looked at the effect of physiological stress responses on executive functioning in the presence of either a real or toy dog. The study involved 38 children aged 8;0 – 14;6 years (N = 34 boys, N = 4 girls) and two dogs approved by school officials were employed. All children attended a special education school and had a formal diagnosis relating to behaviour, PDD, mood, anxiety, motor, psychotic or other, not specified disorder. Children were assigned to either a real or toy dog condition, blood pressure and heart rate were monitored before and after testing in each condition and participants were tested on three executive functioning tasks (coding, memory and inhibition) using standardised tests: Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV), Picture Memory subtest from the Wide Range Assessment of Memory and Learning, Second Edition (WRAML-2) and Inhibition subtest from the NEPSY-II (2007). Blood pressure and heart rate were measured using the Welch Allyn Spot Vital Signs, a device that provided digital measures of non-invasive pressure and pulse rate (heart rate). Results revealed that the presence of a dog had a significant effect on completion speed of the inhibition-naming task ($F (1, 35) = 6.13$, $p = 0.018$). However, no significant effect was revealed for Picture Memory, Inhibition-Naming, or Inhibition-Inhibition scores. Equally, none of the physiological variables of blood pressure and heart rate significantly predicted performance in executive functioning tasks. The study revealed a reduction in physiological arousal had occurred across the length of the intervention, however, this was irrespective of whether the toy or real dog was present. As highlighted above, control groups should be included. In addition to investigating what the most advantageous length and timescales for interventions are, it is also important to look at these in relation to how novelty effects may impact on the intervention in the short term and whether any effects found can demonstrate longevity.

3.4.5 Motor skills and adherence to instructions during motor tasks

Two studies in the review focused on motor tasks in the presence of a dog, Gee, Harris and Johnson (2007) looked at speed and accuracy of a set of gross motor tasks, whilst Gee, Sherlock, Bennett and Harris (2009) looked at pre-schooler's adherence to instructions when carrying out motor tasks. Both studies involved familiarised children with the dogs and used pre-school aged children; Gee (2007) tested 4-6-year-olds (N = 14; N = 5 typical, N = 9 identified), Gee at el (2009) involved 3-5-year-olds (N = 11; N = 5 typical, N = 6 identified).

Both studies use the term ‘identified’ to describe children who have a language impairment, and both involved intervention with a dog.

Gee et al. (2007) asked children to perform a series of 10 motor tasks either in the presence or absence of a therapy dog. A main effect of dog presence was found [$F (1,36) = 7.471$, $p < 0.05$, $R^2 = 0.17$] with children in the dog condition completing the task faster ($M = 10.88$s) than those without a dog ($M = 13.86$s). The type of motor task being carried out was also significant [$F (5,36) =8.133$, $p < 0.05$, $R^2 = 0.31$] with some tasks more accurate in the presence of dog. The authors conclude that the presence of a therapy dog can be beneficial in the execution of gross motor skills and that the dog may act as motivator to performance in children.

Gee et al. (2009) used a motor task experiment to determine children’s ability to follow instructions. Children would perform the task in one of four co-performer conditions: with a real dog, a stuffed dog, a human confederate or no co-performer. Each child had three types of motor tasks to complete: a ‘Modelling task’ in which the co-performer did the task first whilst child watched and then copied, a ‘Tandem task’ in which the child performed the task at the same time as the co-performer and a ‘Competition task’ in which the child competed against the co-performer.

The authors found a significant main effect of co-performer with children adhering to instructions better in the real dog and human confederate conditions than with the stuffed dog or when no co-performer was present ($p < 0.01$, $R^2 = 0.05$). Task type and co-performer interaction also presented significant differences ($p < 0.01$, $R^2 = 0.19$) with pairwise comparisons revealing that the Competition task presented no significant differences regardless of co-performer ($p > 0.05$). In the Tandem task children adhered to instructions better in the presence of a human or stuffed animal ($p < 0.05$) whilst instructions were adhered to better in the Modelling task in the presence of a dog.

Both studies present the beneficial effects of interventions with animals during the execution of motor tasks, discussion for further research focuses on the small sample sizes used within the studies and the need to be able to look more in-depth at whether the presence of the dog showed more pronounced effects within either the typically developing children or the group of children with identified needs.

3.4.6 Adherence to instructions and memory tasks

Gee, Christ and Carr (2010a) explore the effect of a real dog, stuffed dog and human confederate on the adherence to instructions during a memory task. The study involved pre-schoolers of 3 – 5 years of age (N = 12; N = 7 identified, N = 5 typical). The term ‘identified’ describes children who have learning deficits, behaviour deficits or under -developed social skills. The real dog was a certified therapy dog and the study was carried out in two parts. Experiment 1: Children took part in a forced choice recognition task in the presence of a co-performer; real dog, stuffed dog or human. Accuracy of choices and the number and type of instructional prompts required to carry out the task were measured. Task accuracy was at ceiling levels, with all children recognising objects with high levels of accuracy ($p > 0.05$). Analysis of general prompts revealed a significant difference between the real dog versus human conditions ($p < 0.05$) with fewest required in the real dog ($M = 1.17$) as opposed to the human condition ($M = 3.83$). Pairwise comparison of task specific prompts also revealed a significant effect of condition ($p = < 0 .05$) with children in the real dog ($M = 0.83$) and stuffed dog ($M = 1.75$) conditions requiring less prompts than with humans ($M = 2.88$) ($p < 0.05$).

Experiment 2 was conducted six months later with the same children in order to replicate the first study. The study produced highly similar findings and confirmed the reduced need for instructional prompts in the presence of a real dog when completing cognitive memory tasks in the form of picture and object recognition. Hence, the study demonstrated positive results of the dog intervention. The authors discounted the effect of novelty as a reason for the positive effect of the dog due to the familiarisation process they provided, but ask whether the bonding process between child and dog drives the motivation of the child.

3.4.7 Categorisation and object recognition

Three of the papers from the review investigated the effect of the presence of a dog on categorisation and object recognition abilities of pre-school children (Gee, Belcher, Grabski, DeJesus & Riley, 2012a; Gee, Gould, Swanson & Wagner, 2012b; Gee, Church & Altobelli, 2010b). All studies were carried out between a pre-school and lab setting, and testing sessions were single events. Dogs and handlers visited the educational setting on multiple occasions for familiarisation sessions before testing began so that the presence of a dog did not produce a novel situation for the children. The studies involved typically developing and identified pre-schoolers, with the authors defining the ‘identified’ cohort as children who have one or more difficulties in the following areas: oral expression, basic reading skills, listening comprehension and written expression.

In addition, Gee, Belcher, Grabski, DeJesus and Riley (2012a) tested 35–66-month-old pre-schoolers (N = 20; N = 12 typical and N = 8 identified) in their study looking at object recognition performance in the presence of a dog; object recognition involves both cognition and memory processes. Speed and accuracy across performance was measured whilst number of distractor items and collaborator (dog versus humans) varied. Target and distractor items were purposely made similar, thus increasing the difficulty of the task being undertaken by the children. A main effect of number of distractors ($p < 0.01$) was found, with performance higher in the 1 distractor condition vs 4 distractors. A significant effect of latency was revealed with children taking longer to respond in the 4-distractor condition ($p<0.01$) and significant effect of collaborator was also evident for both accuracy and latency, such that performance was best in the dog condition.

Similarly, Gee, Gould, Swanson and Wagner (2012b) tested 38–62-month-old pre-schoolers (N = 17; N = 11 typical and N = 6 identified) and showed that children also responded to exemplars more accurately in the presence of a dog ($p <0.01$). Interestingly, there was a significant effect for animate versus inanimate classification, but this was only revealed in the real dog condition.

Gee, Church and Altobelli (2010b) tested 36–63-month-old pre-schoolers (N = 12; N = 5 identified and N = 7 typical) and looked at the type of choices made by infants in relation to object categorisation in the presence of either a real dog, stuffed dog or human confederate as a co-performer. Infants were required to take part in a ‘match-to-sample’ task with three categories of items to choose from; taxonomic, thematic or irrelevantly linked items. As predicted, the children made significantly fewer irrelevant choices in the presence of a real dog (M = 0.58) ($p < 0.05$) than with the human (M = 1.0) or stuffed dog (M = 2.08). The results of the study also conformed to an expected developmental shift such that younger children made more taxonomic than thematic choices during object categorisation, whereas older children made more thematic than taxonomic choices. The study also revealed differences in the type of categorisation choices being made ($p < 0.05$) with taxonomic choices (M = 22.33) and thematic choices (M = 22.08) being made significantly more often than irrelevant choices (M= 3.67) demonstrating that children made relevant decisions in relation to the stimuli presented. The authors assert a positive effect of the dog on categorisation performance. Consistent with the other studies in this review, the studies focusing on categorisation and object recognition also report positive effects of dog intervention. The authors refer to the need for arousal levels to be measured during future interventions to fully understand the special status of the dog, as opposed to the stuffed animal or human confederate.

The studies reported above, by Gee and colleagues, all rely on relatively small sample sizes, and thus lack broad generalizability. It is important to point out that they also implement repeated measures designs and report moderate to large effect sizes. Repeated measures designs offer the advantage of reducing error variance, by allowing each participant to serve as his/her own control across experimental conditions. Additionally, these studies all involve an important familiarisation period where participants become acquainted with the dog and thus a novelty effect explanation cannot account for the findings.

3.4.8 Effect on classroom behaviour

Three papers within the review investigated the presence of an animal on classroom behaviour in general and with typically developing children**.** Two of the papers investigated the effect of the presence of a dog in the classroom (Kotrschal and Ortbauer, 2003; Hergovich et al., 2002) whilst the third involved a rabbit in the classroom environment (Loukaki and Koukoutsakis, 2014). The research by Kotrschal and Ortbauer (2003) and Hergovich et al. (2002) both included children in classes with a multi-ethnic background aged 6 -7 years. Kotrschal and Ortbauer familiarised the children with three dogs, two of which were certified therapy dogs. They video-recorded the class for a month before dog intervention and used this as a control to compare to videos of behaviour of the children in the presence of one dog during the school days in the intervention period. Video footage was coded for frequency of occurrence and duration across a large range of behaviours and was subsequently subjected to statistical analysis. However, the authors fail to specify the inter-rater reliability to ensure consistency of coding across conditions.

Kotrschal et al. found improved behaviour and, interestingly, more attention focused on the teacher with the dog present, Kotrschal and Ortbauer also reported previously withdrawn pupils as becoming more socially interactive.

Hergovich et al. also tested a class of children with a dog present after previous familiarisation and they used a parallel class of children without a dog present as their control group. Assignment of classrooms to each condition was not random as the dog belonged to the class teacher (p. 41), a potential for bias. Hergovich et al.'s measures included a selection of standardised tests, e.g. The Gestalt Perception Test (a measure of independence), the Vienna Development Test (social intelligence) and a self-assessment of empathy with animals (Killian, 1994) as well as teacher assessments of pupils' sociability.

Hergovich et al. as well as Kotrschal and Ortbauer report a more homogeneous classroom setting with a decrease in behavioural extremes such as aggression and hyperactivity. The rating of pupil's sociability, social integration and aggressive behaviour in Hergovich et al. (2002) was carried out through teacher assessment showing improvements, however, this assessment is open to potential expectancy bias as teachers were not blind to conditions. Hergovich et al. also found significant increases in empathy and field independence, but no differences in social intelligence between test and control group.

Loukaki and Koukoutsakis (2014) evaluated the effect of a rabbit in healthy pupils (N = 39) aged 2;6 - 4 years within a pre-school classroom environment. Children were exposed to a rabbit twice per week for two hours within the classroom. The children could pet and care for the rabbit, in addition to educational activities also being planned around the animal. The authors conclude the pupil's ability of socializing, communicating and expressing emotions increased significantly, however, whilst the study collected data on socialisation, communication and emotional expression, these do not appear to be standardised measures. The lack of procedural detail and control conditions makes the study impossible to replicate and equally impossible to assess any beneficial effects gained through exposure to the rabbit. Additionally, the authors appear to present the rabbit as a commodity with little appreciation of promoting animal welfare to children within classroom settings. Whilst it is important to protect the emotional welfare of children, the authors' view that "rabbits can be practically 'immortal' as they can be replaced with another individual of similar size and colour", lacks respect for the animal and does not promote teaching children respect or animal welfare.

Again, all studies reviewed here report beneficial effects of having an animal in the classroom setting, with a need for randomised controls with longitudinal assessment of the effects being raised as issues. It is also important to emphasise the importance of appropriately trained dogs and consideration of the legal, ethical, risk and welfare implications when carrying out studies with animals.

3.5 Discussion

The current review assessed the extent and variability of research involving animal-assisted intervention to aid student behaviour and learning in the classroom setting. Most, but not all studies concluded a beneficial effect of interactions with an animal.

It is worth noting that as most of the articles lacking significant beneficial effects originated through grey literature databases, this could represent a positive publication bias. All papers within the review were of empirical studies, and ultimately grey literature has provided this review with a more balanced view of animal-assisted interventions previously carried out in schools. Publication bias has implications for many scientific fields of study, including the broader field of Human-Animal Interaction.

Studies within the review consisted of single case designs with the smallest cohort consisting of two participants (Kogan et al., 1999) whilst the largest cohort consisted of 230 children in randomised controlled trials (Tissen et al., 2007). Eight of the studies involved pre-school children from the age of 2;6 years upwards (Gee et al., 2007, 2009, 2010a, 2010b, 2012a, 2012b; Loukaki and Koukoutsakis, 2014, Donaldson, 2016), 16 studies involved school-aged children up to 17;5 years of age and the remaining study spanned across both (Kirnan, 2016). Apart from three, all the studies included a mix of both genders. Male only children were recruited in two studies to reduce variance in the sample (Beetz et al. (2011; 2012) and a further one was due to using a case study design and the availability of suitable participants (Kogan, 1999). One study in the review included gender as a factor in much of their final analysis, but failed to state the gender split in their cohort (le Roux et al., 2014).

In addition to typically developing children, the review highlights that children with a wide range of differing characteristics, including behavioural and learning difficulties, have been involved in research assessing the effect of animal-assisted intervention. These include Autism Spectrum Disorder (O'Haire, 2013, 2014), insecure/disorganised attached children (Beetz et al., 2011, 2012), emotional/behavioural difficulties (Bassette et al., 2013; Anderson 2006, Kogan 1999, Wicker 2005), children with identified deficits and/or difficulties with learning, and language and communication (Gee et al., 2007, 2009, 2010a, 2010b 2012a, 2012b; le Roux, 2014; Becker, 2014) and visual processing challenge, auditory processing challenge and attention focus challenge (Treat, 2013). One study (Kirnan, 2016) included a range of pupils from Kindergarten to 4th Grade, some in special education classes, but failed to specify learning deficits or numbers involved. Two studies also worked with children with a multi-ethnic background (Kotrschal, 2003; Hergovich, 2002),

It is useful to note that whilst the studies reviewed here took place in educational settings, the focus was not necessarily on educational/cognitive effects of interaction with animals. Four studies focused on social functioning (O'Haire, 2013, 2014, Tissen, 2007; Wicker, 2005), three on emotional stability (Anderson, 2006, Beetz, 2013, Kogan, 1999), and three investigated physiological arousals during AAI sessions with children (Beetz, 2011, 2012, O’Haire 2004; Becker, 2014). Three further studies looked at the effect of an animal on the classroom environment in general (Kotrschal, 2003, Hergovich, 2002, Loukaki, 2014).

Whilst most papers within the review report beneficial findings from their interventions with animals, it is evident that further research is needed to extricate and quantify the wide variety of factors involved across the findings. To do this successfully, one important element in this scenario is the design of the research project. Strict methodological protocols are desirable to carry out interventions as planned and are helpful when multiple measures are employed. Furthermore, it is important to learn how measures may interact with each other.

In future, the incorporation of a higher quantity of randomised controlled trials with appropriate control groups would aid in attributing factors directly to the intervention implemented during animal-assisted activities. Control groups are an important element in research design, however, they must be appropriate and serve their purpose effectively. Inappropriate control conditions can fundamentally flaw research outcomes hindering the ability to determine effectiveness of experimental interventions. In this review, five of the studies integrated an independent control group into their design (Beetz, 2013; Hergovich, 2002, Donaldson, 2016, Treat, 2013, Wicker, 2005). Four of the studies used randomised controlled designs with children allocated to different conditions, but none of these had a strictly separate control group of children with no intervention for comparison (Roux et al., 2014; Tissen et al., 2007; Beetz et al., 2011, 2012; Becker, 2014). Ten studies used the child as their own control (O’Haire et al., 2013, 2014; O’Haire 2014; Kotrschal, 2003; Gee et al., 2007; Gee, 2009; Gee et al., 2010a; Gee et al., 2012a; Gee et al., 2012b, Gee et al., 2010b). Of the five remaining studies, three did not include a control group as they used case study designs with between 2 to 6 participants (Bassette et al., 2013; Anderson et al., 2006; Kogan et al., 1999). Two studies under review failed to include an appropriate control group to compare their sample against (Kirnan, 2016; Loukaki, 2014), leaving their results open to interpretation.

Even where controls are implemented, it is vitally important that wider factors are controlled to reduce bias in results, for example the effect of a teacher or school when using a whole class cohort (Beetz, 2013; Donaldson, 2016, Wicker, 2005). These confounding factors represent a design flaw and are a threat to internal validity. Some authors (e.g. O'Haire 2013) acknowledge the potential effect of classroom and school.

The type of design, for example, a repeated measures versus a between-subjects design, also has consequences for interpretation of results. Repeated measures designs have the advantage of each child serving as his/her own control in the study. These designs allow one to examine the dependent measures before and after the animal is present, or to separate out the impact of the animal, from that of a toy version of the animal, from the absence of the animal. It is common for intervention studies to involve small sample sizes and repeated measures designs provide for the collection of a large number of data points, with each subject serving as their own control (reduces error variance), which brings a power advantage over a between subjects design of the same sample size.

It is also important that measures are applied equally. Treat (2013) fails to carry out the main pre-post measurement of reading in the control group condition and while the intervention group demonstrated significant improvement on the task, the study fails to demonstrate the specific effect of the dog, as opposed to the individual researcher / teacher also present in each session.

Further considerations linked to the design of the study concern the length of animal intervention sessions, longitudinal timescales (if any) and the type of animal contact involved. Analysis of the papers in this review revealed a variety of intervention setups and a distinct lack of consistency across the studies. Of the twenty-five studies, nine involved single intervention sessions with a dog present during an experimental task (Beetz et al., 2011, 2012; Gee et al., 2007, 2009, 2010a, 2010b, 2012a, 2012b; Becker, 2014). The remaining studies involved longitudinal intervention between 1 and 12 months with most interventions lasting between 2-3 months (O'Haire et al., 2013; Anderson, 2006; Le Roux et al., 2014; Tissen et al., 2007; O'Haire et al., 2014; Kotrschal et al., 2003; Hergovich et al., 2002; Kogan 1999; Kirnan, 2016; Loukaki et al., 2014; Donaldson, 2016; Wicker, 2005; Treat, 2016). Within these time frames there was also a wide variety of session durations, with exposure to animals ranging from 20 minutes per week (Le Roux et al., 2014, Treat, 2016) to the animal being present in class for the full school day or week (O'Haire et al., 2013, 2014; Anderson et al.2006; Kotrschal et al., 2003; Hergovich et al., 2002). One study varied the intervention duration within the study (Wicker 2005).

The type of interaction taking place was also reported in all the studies reviewed although there is generally not enough information included for complete replication. For example whether the child was seated next to the animal, having direct contact by grooming or petting, versus an animal with exposure to all children in the classroom. Surprisingly, one study included a child with allergies participating in the study using an iPad and so had no direct contact with a dog at all (Kirnan, 2016). Direct contact is a particularly important factor as it may have an impact on the strength and longevity of effects and has been shown to affect physiological processes (Odentaal and Meintjes, 2003).

Only five of the studies reviewed included video analysis of the dog-child interactions taking place (Anderson et al., 2006; Beetz et al., 2011, 2012; Kotrschal et al., 2003; Kogan et al.1999). These studies did associate a deeper bonding process with, for example, increased social and co-operative behaviours in the classroom setting. Further analysis of these interactions could potentially answer the question of whether children will habituate to the presence of a dog over time, and at what point if any, the intervention may cease to be effective.

Further questions arise, for example if the quality of the human-animal relationship makes a difference to the sustainability of the intervention over time. Collecting measures in relation to pet ownership history and a child's attachment to their pet, will also help to ascertain whether these factors are likely to impact on the immediate outcomes of intervention and whether they make a difference to sustainability of effects over time.

Familiarisation with the intervention animal is carried out in some of the studies in order to negate any potential novelty effects of the animal in the pre-school setting (Gee et al., 2007; Gee et al., 2009; Gee et al., 2010a; Gee et al., 2012a; Gee et al., 2012b; Gee et al., 2010b), but is not used as often in other studies within the review. It would be useful to understand more fully what processes of familiarisation are required to counteract novelty effects, and whether there is a trade-off between familiarity and novelty effects in terms of the effectiveness and longevity of the interventions taking place. Furthermore, the familiarisation process and any intervention is likely to lead to bonding between child and dog which in turn can alter the quality of the intervention. This warrants future investigations.

Familiarisation not only has the potential to counteract novelty effects, but also provides an opportunity to ensure that children and staff are trained in understanding stress-signalling behaviour of the animals. This is particularly important when considering the inclusion of dogs in the classroom and the potential risk to both parties involved as dog behavioural signals are often misinterpreted by both children and adults (Meints, Brelsford, Just & de Keuster, 2014). It is therefore important that interventions involving dogs in schools and other educational settings are carried out using trained therapy dogs with trained handlers in attendance.

In the current review, all but three of the studies with dogs used trained or certified therapy or school dogs. Donaldson (2016) involved PAWS for People dogs and handlers in their study and highlights the robust process for inclusion; dogs endorsed by the PAWS organisation are required to pass four sections of the Standards of Excellence (STEX) evaluation. PAWS will fully endorse, and certify, a therapy-dog team only after all areas are successfully completed. In addition, all therapy-dog teams must be re-evaluated every two years to maintain their certification.

In contrast, Anderson (2006) reported that the dog was not trained to interact for the intervention and had not previously experienced younger children, however, Anderson reported the strictest protocol for ensuring safety in the classroom by applying a four-part action plan to reduce risks to children and the dog. This included teaching the children about safe behaviours with dogs, for example, not to touch the dog whilst the dog ate or slept; two other studies also included this beneficial step (Kotrschal, 2003; Hergovich, 2002).

One study (Wicker, 2005) employed a certified dog handler/trainer, but the dogs were pets of other local community members and did not belong to the handler. Worryingly, this study did not involve merely the dog being present in the room, but the students directly trained and interacted with the dog.

Only five of the studies mentioned collecting information on allergies (le Roux, 2014; Bassette, 2013; Beetz, 2013, Becker, 2014; Kirnan, 2016), but six other studies by Gee and co-authors also all included this (personal communication). While it is not stated explicitly within the methodology of the remaining papers reviewed, it is assumed that all the research involving animals would have included allergies as a factor on parental consent forms. Failure to do so would represent a considerable and serious omission.

It is vital that legal, ethical and risk implications must be assessed during design and implementation of research. The welfare needs of children and school staff are paramount in such research, but equally, it is crucially important that the welfare needs of the dog are also carefully assessed concerning type of contact and the length of sessions involving direct contact time with the children (Fine, 2015).

Physiological measures of wellbeing are used as more direct measures that reflect stress and wellbeing in various contexts, including relationships and the bonding process. However, of the twenty papers under review, only three included the assessment of physiological measures; one measured skin conductance (O'Haire et al., 2015) and two analysed cortisol (Beetz et al., 2011, 2012). These studies investigated the benefits of animals as social buffers in the classroom. Surprisingly, none of the remaining seventeen studies took measures of physiological data to form a better understanding of the dynamics involved in human-animal interactions in the classroom. The collection of such measures would supplement researchers understanding of the effect of animals on children's educational attainment.

This is not to say that self-reported measures of social and emotional wellbeing, anxiety and stress are not appropriate. Indeed, checklists or feedback from those taking part may not be a direct measure of arousal or emotional condition, but can provide a detailed insight into the experiences of those involved in animal-assisted activities in schools such as that reported by Wicker (2005). Adding physiological data to the research could provide a richer understanding of the dynamics of human animal interactions by combining a wide variety of both quantitative and qualitative measures for analysis. It would also provide a way to detect unconscious bodily reactions that escape humans' awareness.

Kogan et al. (1999) expressed concern that the two children in their sample received different goals during their intervention with dogs, and pointed out the difficulty in controlling for external factors, especially in research with identified populations who may already be receiving additional services and interventions from other sources. Further to this, it is important that more specific data such as the characteristics, ability and special needs diagnoses of the child are gathered and included into future analyses. Different populations such as those diagnosed with ADHD or ASD often demonstrate differences in physiological reactivity to contact with animals, such as increases in heart rate or reductions in salivary cortisol, contrary to those observed in typically developing populations. The inclusion of physiological measures would allow for a more detailed examination of how individual differences impact on and moderate the effects of animal-assisted interventions.

3.6 Conclusion

This review of animal-assisted intervention in educational settings demonstrated that the majority, but not all the studies reported beneficial effects on cognitive and socio-emotional behaviour and physiological responses. The review also highlights the large variation in design of such studies and identifies multiple external factors that may influence results.

Among the factors that can make it hard to interpret study results are sample selection and size – samples need to be appropriate in size and consistency – so far sample sizes are often small and, for example, contain mixed ages or mixed abilities. Many studies still fail to include an adequate control group into their design reducing the ability to assess the effect of the intervention.

Study designs and procedures would often benefit from more rigor, for example, random assignment to condition, use of appropriate control conditions; use of standardized measures, blind scoring of data, inter- and intra-rater reliability and strict adherence to protocol. This would ensure that effects can be adequately assessed.

Length of interventions, and hence exposure to the animals varied greatly across studies. It is not possible to analyse results of exposure here, but future research could focus on this point and assess timescales for optimal beneficial outcomes. It is furthermore important for researchers to describe the animals involved, the specifics of the interactions that take place during the study, participants' previous experience with animals, and the degree to which the participants are attached to the animals in the study and their own pets. Intervention studies require clear procedures for ensuring treatment fidelity in the study and for allowing for replication by future researchers.

In addition, very few studies included the use of ethological measures, however, the number and type of direct interactions may also provide a deeper insight into the relationship between child and animal, demonstrating a trade-off between the quality and quantity of interactions and the resulting beneficial effects (including direct physiological outcomes). A deeper understanding of the bonding and attachment processes involved during child and animal interactions could be informed through ethological data, enabling researchers to better understand the beneficial effects and ultimately whether certain children may benefit from these interactions than others.

Most of the studies involved dogs, it would be interesting to investigate further if different dog characteristics (e.g., breeds, temperaments, sizes) and different types of animals influence the effects. Is a rabbit or guinea pig as effective as a dog? Does the impact of HAI depend on participants' previous experience with different animal types?

Whilst it is crucial to ensure strict protocols for research design and procedure, it is also important that factors such as interventions and wider services provided by schools are not removed. In the future, it would be useful if these could be either integrated into research design or accounted for during analysis in order to demonstrate robust and applicable interventions in the face of complex requirements. Ideally, and given appropriate training and support, educational establishments may choose to use intervention flexibly and in innovative ways that could give children the best chances of success. Additionally, it would also be useful to establish the most cost-effective methods of intervention to educational settings.

It is important to assess whether including animals in educational settings is valuable or impactful. Do animals help children to learn? Do we see significant improvements in cognitive and socio-emotional behaviour outcomes and are these linked to changes in physiological states? It is vital that future research answers these questions and provides robust evidence as demonstrated through a child's academic and socio-emotional outcome measures. In addition to beneficial outcomes for children, this would also ensure that unnecessary interactions are limited. This in turn may increase welfare considerations for the animals involved. In short, we need to determine the optimum and most effective course of intervention to provide the best outcomes for children.

Lastly, but importantly, research involving AAI needs to ensure a strict and thorough protocol for risk assessment measures such as the training level and certification of dogs/handlers, allergy and phobia information, and child safety training in relation to understanding dog behavioural signals; these will ultimately protect the welfare and safety of staff, children and animals involved in interventions.

3.7 Summary

Due to the number of distinct studies and the divergent nature of methods employed across animal intervention research, it is difficult to ascertain with any certainty the most effective model of intervention with animals in the classroom setting.

As described above, previous literature reviews have highlighted research examining the impact of AAI on child and adolescent health and well-being (Busch, Tucha, Talarovicova & Fuermaier, 2016; Maujean, Pepping & Kendall, 2015; Kamioka, Okada, Tsutani, Park, Okuizuma, Handa, Oshia, Park, Kitayuguchi, Abe, Honda & Mutoh, 2014; Friesen, 2010;), the effect of animals on children and adolescents with Autism Spectrum Disorder (ASD) (Davies, Scalzo, Butler, Stauffer, Farah, Perez, Mainor, Clark, Miller, Kobylecky & Coviello, 2015; O'Haire, 2013b) and on reading (Hall, Gee and Mills, 2016).

In short, previous reviews have concluded that some beneficial effects of HAI with children exist, but they also highlight a variety of shortcomings. O'Haire (2013a) reported an increase in the number of AAI studies relating to children with ASD, with studies being variable and spanning a variety of disciplines. However, a lack of consistent terminology and research protocols is also reported. Davies et al (2015) concluded that a positive relationship between child and animal existed, but criticised a lack of efficacy of the interventions and multiple methodological flaws across the literature under review. Likewise, Kamioka et al (2014) emphasised problems with the conduct and reporting of studies and concluded that many were of relatively low quality. It is therefore important that researchers take note of these criticisms to ensure that future studies are designed and carried out to a high standard; that methodological flaws are eradicated, and protocols are consistent and appropriate.

CHAPTER 4: Animal-assisted interventions in schools – knowledge gaps and open questions

It is evident from the systematic review that gaps exist within the literature as to the effect of AAI on children's learning and development within the educational setting. In order to carry out a robust investigation of the topic it is important that cognition, language, socio-emotional function and wider physiological measures are assessed. This chapter discusses the importance of each area of function to children's learning and development, giving appropriate summaries of relevant background research to support its relevance. Please note that exhaustive literature reviews on these topics are beyond the scope of this thesis. Areas of AAI research that have been carried out within schools were highlighted with reference to the systematic review (chapter 3), and gaps in the research are outlined. The chapter concludes by presenting hypotheses for the thesis.

4.1 Cognitive function

Children's global cognitive functioning develops over the first two decades of life, with levels of cognitive processing becoming more complex over time. As sensory information is gained through the perceptual process, it is incorporated into a coherent working model through the integration of auditory-verbal and visuo-spatial processing systems (Elliot & Smith, 2011). This development allows changes in mental representations, which become more complex with age and provide the child with greater flexibly in the type of strategies they are able to apply across differing contexts, which ultimately influence behaviour (Bjorklund & Causey, 2018).

Memory, attention and executive functioning work together to provide an efficient system for the acquisition of information, its storage and its application. For example, Beattie, Schutte and Cortesa (2018) found that inhibitory and attentional functioning in children was related to spatial working memory, with better inhibitory and attentional ability linked to greater spatial working memory. These related abilities impact on academic performance and are integral to the learning process overall. Executive functioning is closely associated with specific areas of academic development such as achievement in mathematics (Nesbitt, Fuhs & Farran, 2018; Purpura, Schmitt & Ganley, 2017) and developing skills such as executive functioning and maths achievement are bi-directional during early development (Nesbitt et al., 2018; Fuhs, Nesbitt, Farran & Dong, 2014; Schmitt, Geldhof, Purpura, Duncan & McClelland, 2017; Welsh, Nix, Blair, Bierman & Nelson, 2010). Mathematical skills emerge early in development and are relatively stable, with early skills predictive of later outcomes (Duncan et al., 2007).

Similarly, working memory and inhibitory control are intimately linked in executive function which is central to factors such as concentration, thinking and acting on impulse (Diamond, 2013). Executive functioning is crucial to cognitive processing and involves a series of integrated neurological activities that are responsible for goal-directed behaviour (Lezak, 1995). There are three core areas within executive function, namely working memory (active maintenance and manipulation of information), cognitive flexibility (ability to switch rapidly between tasks) and inhibition (inhibitory control) (e.g. Miyake, Friedman, Emerson, Witzki, Howerter & Wager, 2000), with all being important for self-regulatory behaviours.

Executive function is also important for children's ability to self-regulate which requires inhibitory control, working memory and attention to work together. Self-regulation develops with age, as more control over, and integration of the three areas of processing develops (Skibbe, Montroy, Bowles & Morrison, 2018). Research also highlights how self-regulatory behaviours are closely linked with academic development. Skibbe, Montroy, Bowles & Morrison (2018) report that self-regulation is also associated with higher levels, and earlier development of language skills, specifically decoding and reading comprehension.

It is also seen to be a significant predictor of mathematical ability (Blair, Ursache, Greenberg, Vernon-Feagans & The Family Life Project Investigators, 2015).

Classroom cohesion is important for an effective learning environment. Inhibitory control allows for a child to control impulsive behaviour, to focus in the face of external distractions and to choose how best to react to stimuli and situations. In its wider context, children who lack inhibitory control are more likely to exhibit poor behavioural patterns which can lead to disruption within the educational environment. In addition to affecting the child's learning potential, this can result in classroom disruption which affects other children's learning and behaviour. Kotrschal and Ortbauer (2003) found the introduction of a class dog improved children's attention to the teacher, and that previously withdrawn pupils showed increased social interaction. Similarly, Hergovich et al., (2002) found that the inclusion of a dog within the classroom environment enabled children to be more independent learners. Studies also suggest that a wider behavioural effect of increased attention/engagement may be at work during or after AAI with a dog (see Chapter 3: Gee et al., 2010; Gee et al., 2009; Bassette & Taber-Doughty, 2013). However, whilst the research points to the dog having a positive effect, it offers no explanation as to the mechanisms/neural domains responsible for such effects and how the dog may have preferentially impacted on their functioning. Understanding whether different areas of cognitive processing such as memory, attention and executive functioning are affected more than others during AAI will allow for more bespoke interventions aimed at specific learning deficits which hinder children's learning.

Ling and colleagues proposed that a variety of programs can be implemented to successfully improve executive function and inhibitory control and that activities impacting on areas such as social or emotional functioning may indirectly support executive function and inhibition (Ling, Kelly & Diamond, 2016). The application of an animal-assisted intervention may be such a program and is of interest in this research. If animal interactions impact on these functions, it would be useful to understand which, and in what way, in order to support learning within schools. Research on object recognition through memory performance by Gee, et al., (2012a), Gee et al., (2010) and Gee et al., (2009) (see Chapter 3, systematic review) allows us to narrow down the domains and types of behaviours affected during human-animal interactions as they test more specific areas of cognitive processing under AAI conditions within their experimental sessions. These studies demonstrate that the presence of a dog impacts on some specific cognitive and behavioural domains, however, evidence is sparse and more is needed to assert firm conclusions as to which domains are most affected and why.

In order to test if animal-assisted interventions can make a significant contribution to cognitive processing within the educational environment, it is important to understand the processes involved in cognition and learning. The impact of an intervention across non-verbal, spatial and speed reaction time tasks must also be assessed in order to pinpoint the key processes at work during AAI sessions. The current research will address these topics in Chapters six to ten.

4.2 Categorisation and Language

4.2.1 Categorisation.

The ability to categorise is fundamental to early information processing and plays an important role in both concept and language development (Rosch, 1978; Rosch & Mervis, 1975; Rakinson & Oakes, 2003; Bornstein & Arterberry, 2010). This relationship is reciprocal and as the child develops, the integration of information about objects and the correlations between them is gradually integrated with, and can also be shaped by language, allowing increased conceptual processing (Westermann & Mareschal, 2012). Categorisation abilities can be seen to follow a developmental trajectory (Kovack-Lesh, Horst & Oakes, 2008), and are influenced by previous experience and developmental environment (Kovack-Lesh, et al., 2008; Vanmarcke & Wagemans, 2015). Abilities can also be affected by task context and prior learning (Mareschal & Quinn, 2001).

Infants can form early perceptual categories based on simple patterns such as geometric figures (Quinn, 1987; Bomba & Siqueland, 1983). Later, representations of objects become more complex with infants utilising naturally occurring perceptual properties at a basic level. For example Quinn and Eimas (1997) found that infants could form categories of domestic cats, which included novel cat exemplars but excluded dogs and horses. This could also be extended to a global category of representation such as mammals which excluded items of furniture. Infants also appear to use featural information which co-varies across different exemplars in order to form distinct categories of objects (Spencer et al., 1997; Younger & Cohen, 1986). These early perceptual representations provide the infant with a base which enables conceptual and inferential thought, related to language (Mandler, 2009).

Correspondingly, studies have shown that the presence of a dog had a significant effect on pre-schoolers categorisation (Gee, Church & Altobelli, 2010b), object recognition (Gee, Belcher, Grabski, DeJesus & Riley, 2012a) and the ability to categorise animate objects faster and more accurately (Gee, Gould, Swanson & Wagner,2012b), (see chapter 3). The processing of animate versus inanimate objects in Gee at al., (2012b) was particularly interesting as this was only revealed in children who participated in the real dog condition. Understanding what factors are involved and how these impact on processing abilities during interaction with a dog, may potentially allow the practice to support deficits in specific areas of learning.

4.2.2 Language abilities.

Category development underpins language competencies, with typically developing children’s language skills being well developed by the time they reach formal school age.

This development is continuous, with typically developing children becoming more proficient as wider task demands increase. Sadly, many young children entering the formal education system do not have the language skills to meet the social and academic needs of the classroom environment (Norbury, Gooch, Baird, Charman, Simonoff & Pickles, 2016). In addition to interactions with their peers, children within the school environment need to be able to follow instructions, ask questions and produce written language. This is also important for wider metacognitive skills allowing the child to utilise and think about language itself. Furthermore, it is important to understand how differing domains of language processing impact, and often rely, on each other in order to perform proficiently. For example, receptive and expressive language are important in the identification of words, a deficit in one is likely to have a detrimental impact on other areas of language development (Wise, Sevcik, Morris, Lovett & Wolf, 2007). Language deficits are more far-reaching than impacting on domains within language development alone. A deficit in language abilities will have a knock-on effect in every other area of learning within the school environment and so is critical to the learning process itself (Law, Charlton & Asmussen, 2017). Importantly, Slot and von Suchodoletz (2018) reported that language skills were reciprocally related with executive functioning, and that language skills are a significant predictor of executive functioning outcomes.

Supporting early language development will therefore aid in the enhancement of executive functioning skills which, as already discussed, are integral to wider cognitive functioning. Language skills are also related to mathematical development (Kleemans, Segers & Verhoeven, 2011; LeFevre, Fast, Skwarcchuf, Smith-Chant, Bisanz, Kamawar & Penner, Wilger, 2010), and Chow and Ekholm (2018) suggested that it is not just language ability that is a predictor of mathematical performance, but rather that syntactic ability specifically can predict problem-solving skills in maths. It is therefore important to emphasise that language does not stand in isolation and that wider skills and learning can be aided by supporting language development.

Syntactic processing is the ability of children to understand and utilise the grammatical structure of language, i.e. the rules governing the combining of words to form sentences (Saxton, 2017). Children's comprehension when reading also relies on the ability to understand how words are arranged to convey meaning (Otto, 2015). Le Roux et al. (2014) tested comprehension and reading rate in the presence of a dog (see chapter 3), and more recent research by Schretzmayer, Kotrschal and Beetz (2017) and Linder, Mueller, Gibbs Alper & Freeman, (2018) did not find significant effects for language comprehension with AAI. It is of note that Schretzmayer et al., (2017) reported an increase in children's reading rate when a dog was present in the second test session, whilst Linder et al., failed to find an increase in reading rate but did find significant differences in attitudes towards reading after intervention, suggesting a change in motivational attitudes of children towards the topic. It is also of note that these studies are assessing reading comprehension in general which is not the same as testing sentence comprehension (Scott, 2009). Much more literature is available in relation to dog-assisted reading which has become a very popular intervention currently used in school settings and has also attracted more research interest than other animal-assisted topic areas (chapter 3; see also Hall et al., (2016) for overview).

It is therefore evident that while reading in the presence of a dog is assessed through research, a large gap exists in relation to the assessment of specific language skills in the presence of an animal within the educational setting, and consequently the impact of such interventions on children's learning. Neither sentence comprehension, nor grammatical abilities of children have been assessed with respect to AAI using standardised measures. It is therefore not possible to say whether these functions may be supported through the application of AAI in schools. The current research will close this gap.

4.3 Social and emotional processing: self-esteem, anxiety and behavioural functioning

Emotional development and engagement with others can be observed from an early age with prosocial behaviours emerging during infancy (Hepach & Warneken, 2018; Brownell, Svetlova, Anderson, Nichols & Drummond, 2013; Schmidt & Sommerville, 2011; Decety, 2010). Emotional understanding develops as the child matures allowing them to understand the thoughts, and feelings of others, understand social situations, follow rules and also self-regulate in different situations (Rosen, 2016; Brownell, et al., 2013). As neurocognitive mechanisms develop within the child, so does the ability to regulate such behaviours (Steinbeis, 2018).

4.3.1 Self-esteem

Children's favourable attitudes towards themselves represents a measure of self-esteem and are also an important area of social functioning (Stets & Burke, 2014). Specific factors which are often linked with self-esteem in young children include areas such as academic competence (Daniel & King, 1997; Mann, Hosman, Schaalma, & De Vries, 2004), physical appearance (Barker & Bornstein, 2012; Mäkinen, MPuukko, Viertomies, Lindberg, Siimes, & Aalberg, 2012), relationships with others (Grunebaum & Solomon, 1987). These domain-specific areas of self-esteem are subject to age-related changes. As the child develops, they are exposed to new experiences, new and changing roles and relationships with others, and new challenges which impact on their perceptions of their self-worth (Rosen, 2016) and behavioural conduct (Mann, Hosman, Schaalma, & Vries 2004; Leary, Schreindorfer & Haupt, 1995). Self-esteem in 5-year-olds has also been found to equate with the child's gender identity and gender in-group preferences, with pre-schoolers displaying properties of social cognition relating to the functioning of group identities, associated with adult social cognition (Cvencek, Greenwald & Meltzoff, 2016). If implicit self-esteem in the pre-school years confirms the maintenance of a balanced identity, then it is vitally important that positive self-esteem is fostered throughout childhood. Measuring global self-esteem in children will provide a reflection the child’s confidence, initiative and independence, as well as their ability to deal with, and react to stress (Harter, 2012).

It is therefore important that children’s social and emotional skills are adequately supported, considering that they are pivotal to a child’s success within the school environment, are correlated with academic achievement and also impact on later outcomes into adulthood (Murray & Palaiologou, 2018; Denham, Bassett, Brown, Way & Steed, 2015; Clarke, et al., 2015). Empathetic and prosocial behaviours are beneficial to wider emotional, psychological and social conduct, and are linked with morality and the regulation of aggression (Hepach & Warneken, 2018; Silke, Brady, Boylan, & Dolan, 2018; Decety, 2010). Research has shown that whilst genetics and environment both play a part in an individual’s ability to empathise (Hepach & Warneken, 2018), the level of empathy stays relatively constant and shows little age-related decline (Grühn, Rebucal, Diehl, Lumley & Labouvie-Vief, 2008). Ensuring such behaviours are underpinned during a child’s early years will therefore result in more optimal levels of functioning across the lifespan. While there appears to be little research relating to animal-assisted interventions which tests children’s self-esteem directly, research by Schuck, Johnson, Abdullah, Stehli, Fine and Lakes (2018) did show that factors within a self-esteem measure such as self-perceptions of behavioral conduct, and social, and scholastic competence improved after dog-assisted intervention. Again, further research is warranted to address the knowledge gap in this area.

4.3.2 Empathy

Greater empathy has been reported in children who hold close relationships with their pets (Hawkins, Williams & SPCA, 2017; Williams, Lawrence & Muldoon, 2010; Daly &

Morton, 2006; Melson, 2003; Melson, Peet & Sparks, 1992; Bryant, 1985). This ability to empathise and understand the feelings of others is an important part of social cognition. Children who lack in social cognition are more likely to be at risk of academic failure, peer rejection, loneliness, school exclusion, later problems with illegal substances and experience of the prison system (Rutherford, Quinn & Mathur, 2004). It is also important to recognise that individuals with conditions such as Autism Spectrum Disorder (ASD), Conduct, Mood and Anxiety disorders have also been shown to have impairments in social skills and empathy (Ogundele, 2018; Decety, 2010; Rutherford et al., 2004).

Previous research highlights possible gender differences in emotional processing, with females better at evaluating empathy than males (Bosacki & Astington, 1999; Baron-Cohen, O'Riordan, Stone, Jones, & Plaisted, 1999; Baron-Cohen, Wheelwright & Hill, 2001). This social perception is demonstrated early in life, with one-day old female babies preferring faces as opposed to mechanical toys, which are preferred by male babies (Connellan, Baron-Cohen, Wheelwright, Batki, & Ahluwalia, 2000).

According to the empathizing-systemising (E-S) theory, these differences in processing reflect biological neurological systems, whereby females show stronger empathizing and males show stronger systemising tendencies (Baron-Cohen, Knickmeyer & Belmonte, 2005). Auyeung, Wheelwright, Allison, Atkinson, Samarawickrema and Baron-Cohen (2009) reported that typically developing girls scored significantly higher on the empathising quotient than typically developing boys, and that boys scored significantly higher on the systemising quotient.

This pattern of processing also tends to affect children diagnosed with disorders such as ASD and Asperger's Syndrome disproportionately, with children scoring higher on systemising than empathizing behaviours regardless of gender. Social anxiety and heightened arousal during social interactions are also reported in such populations (Corbett, Muscatello

& Blain, 2016; for overview see Spain, Sin, Linder, McMahon, & Happé, 2018) in addition to impairments in social skills (Bowler, 2007; Rutherford et al., 2004). The application of animal-assisted activities was found to aid such children within the classroom setting, with guinea pigs seen to improve social functioning and reduce both social withdrawal and problem behaviours in children diagnosed with ASD when compared to typically developing peers (O'Haire, et al., 2013; 2014). The animal may therefore act as a social buffer for such populations (O'Haire, 2015).

The animal as social support or "social facilitator" (McNicholas & Collis, 2000, 2001) appears to be an emerging theme in many of the studies looking at animal-assisted activities. Schmid (2011) concluded that children with emotional-behavioural disorders reported increased levels of empathy, social interaction and social cooperation following interaction sessions with farm animals. Likewise, research carried out with children suffering with socio-emotional and attachment difficulties also showed improvements via the application of AAI sessions within the classroom environment (see Chapter 3: Anderson et al., 2006; Beetz, 2012; Hergovich et al., 2002; Kogan, et al., 1999) whereby the dog may be seen as providing social support to the child.

4.3.3 Anxiety

Stress and anxiety can negatively impact on executive function and working memory processes (Lupien, Maheu, Tu & Fiocco, 2000; Diamond & Lee, 2011; Mowbray, 2012). Executive functioning, attention and inhibition form part of an integrated neurological process and are affected by emotional processing (Miyake et al., 2000; Rebetez, Rochat, Billieux, Gay & Van der Linden, 2014; Schulz, Fan, Magidina, Marks, Hahn & Halperin, 2007; Phelps, Ling & Carrasco, 2006). These are important areas of functioning which should not be overlooked, especially in light of the fact that large numbers of pupils with emotional disorders fall behind in their educational attainment, and that multiple risk factors can influence behavioural adjustment and psychosocial functioning across the life span (Sabates & Dex, 2012; Goodman, Joyce & Smith, 2011; Green, McGinnity, Meltze, Ford & Goodman, 2005). Importantly, children and youth with anxiety disorders often exhibit behavioural difficulties (Franco, Saavedra & Silverman, 2007; Nantel-Vivier, Pihl, Côté & Tremblay, 2014). These behaviours may manifest themselves in different ways depending on the individual child and their wider familial characteristics (Nantel-Vivier, et al., 2014). However, regardless of the type of behaviour, for example, internalising or externalising behaviours, these will have to be accommodated within the classroom environment.

As an effective classroom environment is dependent on a multitude of factors, including, but not limited to, children engaging with both their teachers and peers, self-regulatory behaviours of the child and the willingness to co-operate. It could therefore be assumed that a positive effect on these behaviours, for example via animal-assisted interventions, would also impact positively on classroom function (see Chapter 3: Hergovich, et al., 2002; Kotrschal et al., 2003).

Animal-assisted interventions have the potential, not only to impact on whole class behaviour and improved learning outcomes, but also may be able to provide cost efficiencies for schools through whole class interventions. Assessment of the difference between one-to-one and group AAI sessions therefore need to be investigated. This is important, as the application of an AAI to a whole class would be less costly than one-to-one sessions. It would in turn also decrease the amount of direct contact for animals, which reduces unnecessary working hours for animals. So far, no comparison of individual versus group interventions has taken place. The current project will also close this knowledge gap and will be able to make recommendations for stakeholders.

4.4 Physiological function

Research has demonstrated how human-animal interactions impact on the physiological functions of both the human and the animal, with mutual benefits for both parties (Odendaal & Meintjes, 2003). However, this is not a linear relationship and does not affect both parties equally, but depends on the quality of the relationship (Millot & Filiatre, 1986; Millot, Filiatre, Gagnon, Eckerlin & Montagner, 1988; Hall , Liu, Kertes & Wynne, 2016) and wider contextual factors (Schöberl, Wedl, Beetz & Kotrschal, 2017; Petersson, Unväs-Moberg, Nillson, Gustafson, Hydbring-Sandberg & Handlin, 2017; Odendaal & Meintjes, 2003). For instance, the quality of the interaction with the animal may be a factor, as demonstrated by a decrease in cortisol levels being associated with increased stroking and petting of a dog in children with insecure attachment profiles, as reported by Beetz et al., (2012) and type of initiation of such contact also appears to be a factor (Kertes, Liu, Hall, Hadad, Wynne & Bhatt, 2017).

Assessing physiological functioning of the child during HAI sessions allows for a deeper insight into important objective measures of functioning which are otherwise missed, or have the potential to be distorted through subjective self-report measures. For instance, Hediger and Turner (2014) found that attention measured through PIR HEG (passive infrared hemoencephalography) stayed constantly higher in the presence of a real dog but decreased in the presence of the robotic dog. PIR HEG measures physiological signals from the forebrain based on thermal output arising from changes in blood flow and cellular metabolism. Measures are correlated with cognitive activity through thermal emission from the forehead (Carmen, 2005). So, whilst Hediger and Turner's attentional tasks do not all reveal significant differences in the presence of a dog, the PIR HEG points to an underlying effect of the dog on children's physiological functioning that was not revealed through overt cognitive testing procedures. Factors relating to stress and social anxiety may otherwise be unobservable, for instance having a dog present during social situations resulted in decreased skin conductance responses for children with ASD, providing a stress buffering effect to children who showed heightened arousal in other no-dog conditions. (O'Haire, et al., 2015).

4.4.1 Cortisol

All individuals, adults and children alike, need to maintain a state of equilibrium or homeostasis, yet conversely are continually challenged by both internal and external adverse factors known as stressors (Chrousos, 2009). Stress results when homeostasis is breached due to adverse factors which exceed actual or perceived thresholds of the individual concerned. As an individual encounters stressors, the autonomic nervous system (ANS) is activated through the hypothalamus. This evolved adaptive response results in epinephrine, a hormone and neurotransmitter (also known as adrenaline) to be released into the blood stream. This prepares the body for the important fight-or-flight response and results in a series of physical changes such an increase in an individual's respiratory rate, heart rate, blood pressure and increased blood sugar. In turn, hormonal changes also occur such as the secretion of glucocorticoids through the hypothalamic-pituitary-adrenal axis (HPA); the primary end product of the HPA being cortisol (Cacioppo, Tasinary & Bernston, 2016; Hellhammer, Wust & Kudielka, 2009).

Cortisol can therefore be used to assess a child's physiological functioning, both long-term or in relation to specific events through an acute measure (for overview see Dimolareva, Gee, Pfeffer, Maréchal, Pennington & Meints, 2018; Nicolson, 2012). The collection of free cortisol derived from saliva in children is fairly easy to obtain, less intrusive than other methods of collection and is a relatively stable substance (Hanrahan, McCarthy, Kleiber, Lutgendorf & Tsalikian, 2006; for wider discussion see Dimolareva et al., 2018). Researchers must be mindful of the variability within and across samples. Cortisol typically follows a circadian rhythm during which cortisol increases a few hours before waking and gradually decreases over the course of the day, reaching its lowest levels in the evening (Sjors, Ljung & Jonsdottir, 2014; Kirschbaum & Hellhammer, 1989). In addition to changes across the diurnal curve, the HPA axis can also show large intra-and inter-individual variations in response to stress (Kudielka, Hellhammer & Wust, 2009).

During acute stress, wider changes take place in the central nervous system (CNS), which includes activation of various pathways relating to adaptive functions such as arousal, vigilance and focused attention whilst inhibiting functions such as eating and growth (Chrousos, 2009). As it is well established that educational attainment is affected by stress, mental health disorders and child well-being (Murphy & Fonagy, 2012; Suhrcke & de Paz Nieves, 2011), and that stress responses during childhood are also known to be a risk factor in stress-related disorders in adulthood (Ingram & Price, 2010), it is therefore imperative to understand how this may be mediated to support children's well-being in general, but also in relation to their educational performance within the classroom setting.

As with the previous topics within this research, there is a distinct lack of human-animal research which also incorporates the collection of cortisol within the educational setting, leaving a gap in research evidence. The few studies that can be cited so far are those of Beetz,et al. 2011 and Beetz, et al. (2012) who investigated the social support of dogs and included the collection of cortisol from saliva (see Chapter 3). Conversley, a more recent study looking at the effect of AAI on children's reading performance by Schretzmayer, Kotrschal & Beetz (2017) reported that the children in the dog condition had increased cortisol levels than those in the no-dog condition. Of note is that Schretzmayer et al (2017) used an experimental setting for their study which may have impacted on the arousal levels of children not used to the environment. Studies involving university students also found cortisol reduction after interaction with dogs (Pendry & Vandagriff, 2019; Polheber &

Matchock, 2014) with both studies asserting short term momentary advantages of AAI. And lastly, Kertes et al. (2017) looked at the effect of pet dogs on children's perceived stress levels and cortisol responses whilst under stress. No significant effect of cortisol was found, however, lower cortisol was associated with more child-initiated pet contact under stressful conditions. Consequently, it is important that further work is done in a systematic manner and in an attempt to further understand the physiological impact of animals, dogs specifically, and how this links with performance within the classroom.

4. 5 Sleep

Sufficient good quality sleep is essential for healthy child development, with improved attention, behaviour, learning, memory and emotional regulation benefiting from children getting enough sleep (AASM, 2016). Sleep is important for the performance of both psychological and physiological functioning in children and plays a vital role in educational attainment through memory consolidation (Ashworth, Hill, Karmiloff-Smith & Dimitriou, 2014). As with other functions, sleep involves multiple brain regions and neurochemical processes which are intimately linked with memory. These have the potential to impact on sleep quality especially in relation to stressful memories. The hypothalamus and amygdala are significantly related to the modulation of sleep and together with the medial prefrontal cortex play a role in mediating the effects of stress on sleep (Sanford, Sushecki & Meerlo, 2015). Ivanenko, Crabtree, O'Brien and Gozal (2006) found that children with mood and anxiety disorders have more frequent night-time awakenings, and that sleep duration and latency were also correlated with factors of aggression, hyperactivity and depression. These factors have the potential for negative impact on children's functioning within the classroom setting and academic performance (Phillips, et al., 2017; Kelly, Kelly & Clanton, 2001).

Whilst animal-assisted intervention has been linked with positive behavioural improvements in teenagers diagnosed with acute mental illness such as mood and eating disorders, schizophrenia and anxiety (Stefanini, Martino, Alllori, Galeotti & Tani, 2015), no research is available to demonstrate the effect of animal interaction on children’s sleep habits. Previous studies with adults do report that female dog owners describe having fewer bad nights’ sleep than non-dog owners and that the owners of companion animals take less medication for sleep difficulties (Headey, Na & Zheng, 2008; Headey, 1999). It is therefore important to gauge whether dog-assisted intervention has an effect on children’s sleep, and if so, how this might correlate with measures of anxiety and academic performance.

4.6 Motivation, Rationale and Hypotheses

4.6.1 Motivation

While some research has produced promising results, research in the field of AAI often lacks rigour, and results often have limited scope (see Chapter 3). In order to assess with the necessary rigour, improve the knowledge in the field, and to find out which mechanisms underlie the potential benefits of AAI, randomised controlled trials were run longitudinally. The effects of AAI were investigated in areas of cognition, language, categorisation, socio-emotional, behavioural and physiological measures in school children were research gaps exist. Due to the above described potential benefits of AAI in schools and the criticisms highlighted in Chapters 3 and 4, this research was designed to produce a methodologically sound study to examine the effects of a dog intervention on children’s cognitive and socio-emotional development, and on their physiological and behavioural functioning within mainstream schools. This project investigated and assessed ‘what works’ systematically and longitudinally, under as tightly-controlled conditions as possible and in adherence to a strict RCT testing protocols. High standards of dog and human safety and welfare were maintained throughout.

4.6.2 Rationale

To rigorously test the effects of a dog-assisted intervention, the study was designed to include a comparable active control condition, in addition to a no-treatment control condition. Research literature often cites the biological mechanisms active during interactions with companion animals and during AAI sessions, such as lower cortisol, reduced skin conductance, lower blood pressure and heart rate (see Herzog, 2011 for overview). In light of this, a relaxation condition using meditation was employed as an active control condition due to the many similar biological effects reported (see Chapter 1; Telles, et al., 2013; Hagen & Nayar, 2014; Mendelson, et al., 2010; Tang et al., 2007). Testing potential differences between the two will provide an insight into whether dog interventions have beneficial effects over an alternative relaxation technique.

As discussed previously, further research is needed which looks at more specific areas of cognition such as problem solving, memory, executive function and speed reaction time tasks (SRT). This project tested non-verbal reasoning abilities separately to those of language processing. Standardised tests of cognition included measures of spatial ability and non-verbal reasoning, which together could be combined to produce a global measure of non-verbal cognition, referred to as a Special Non-Verbal Composite (SNC). As executive function and inhibitory control do not feature in previous literature relating to AAI studies conducted in the classroom, a Fruit Stroop task measured inhibitory functioning, and was carried out as a SRT task. Apart from reading studies, no literature was found for the effect of dog-assisted intervention on practical school tasks which children typically perform within the classroom environment; this study included a maths task, designed to be of a difficult nature to reflect problem-solving abilities in the presence of a dog. Categorical processing underlies early language development (Rosch, 1978; Rosch & Mervis, 1975; Rakinson & Oakes, 2003; Bornstein & Arterberry, 2010), therefore a categorisation task was completed by the children which incorporated an assessment of animacy in relation to AAI sessions. This task built on that of Gee et al., (2012b) by being carried out as an electronic SRT; this allowed a much more precise measure of cognitive processing to be collected. The task also looked at how children's processing of animacy was affected by interaction with an animal. As above, whilst there are many studies relating to reading-with-dogs, research relating to specific language functions is absent from the literature.

This study collected data on sentence comprehension and syntactic formulation which represents a measure from both language production and comprehension. This provided a closer look at exactly what areas of language processing were affected by AAI.

Whilst there are some assessments of the effects of AAI on social, emotional and behavioural functioning on children, many of these studies represent atypical populations specifically recruited with difficulties in these areas of function, or are case study designs. This project assessed these functions within a typically developing school population and in a robust fashion with a sufficiently large cohort of children. Data on anxiety and self-esteem of the children was collected across the study. Behavioural measures were completed at the beginning of the project and after interventions. These gathered data on behaviour in the home (as reported by parents) and behaviour within the classroom (as reported by teachers). As background literature often relates interaction with pets and other animals to empathy and emotional processing (see Chapter 4), this study also collected data through the Empathy/Systemising Quotient (EQ-SQ) in order to assess whether either of these qualities was affected by interaction with a dog.

Very few studies have previously collected physiological data within the classroom environment to assess the effects of AAI, and in the process investigate how this interacts with the above measures of cognition, language and behaviour (see Chapter 3). This study collected salivary cortisol as a measure of stress regulation in children. Baseline cortisol was also collected before and after interventions in order to assess background levels of cortisol function over the school term. The study also collected acute cortisol directly before and after three individual intervention sessions to investigate immediate effects of AAI on children's functioning.

To date, no data is reported for the effect of AAI in the classroom on sleep functioning in children. This study therefore collected data on sleep efficiency through a sleep diary completed by parents and children over a 6-week school term in which interventions were carried out.

No previous research has systematically tested the effects of the type of AAI sessions conducted. The literature is varied with how AAI sessions are carried out. Some involved a more personal interaction for the child through one-to-one sessions with the dog and handler, while others are carried out as whole class, or large group interventions (see Chapter 3). It therefore remains to be seen whether these scenarios produce tangible differences for the intervention. However, if group or class sessions are as effective as one-to-one interventions, this will have positive impacts on dog welfare (the need for less working hours) and educational budgets (through greater cost efficiencies). Uniquely, this study carried out this assessment by ensuring that interventions were conducted under both types of scenario, and the effects on cognition, language, behaviour and cortisol were assessed in relation to each.

Lastly, but importantly pet-ownership has been reported as conveying a host of benefits to human-beings (see Chapter 1 and 4). This study assessed the effect of children's dog ownership status on scores of cognition, language, behaviour and cortisol, in order to investigate whether key differences existed between dog-owning children, and those without a dog at home. The study also investigated whether intervention-sessions with, and without a dog, or a relaxation intervention, conferred advantages to one group over the other.

This study used a longitudinal, randomised control trial design. Children were assigned to one of three intervention conditions: dog, meditation or control group. Intervention sessions were carried out twice per week, for 20 minutes over four weeks. Two types of intervention scenarios were tested within the study, with children taking part in either one-to-one or small group sessions with other children. In order to assess potential long term effect of the AAI sessions, children were tested on a range of cognitive, socio-emotional, behavioural and physiological measures before (pre) and immediately after (post) four weeks of intervention, and additionally after 6-weeks, 6-months and 1-year time points.

Cortisol was collected as a baseline measure before interventions began, and again after four weeks of intervention. Acute cortisol was also collected immediately before and 30minutes after the 1st, 4th and 8th intervention sessions for those in the dog and relaxation conditions.

4.6.3 Hypotheses

1. General learning and maturation effects will be expected in all cognitive, socio-emotional and behavioural measures.
2. Intervention effects are expected when comparing performance before and after intervention, as follows:
    a. Children taking part in dog-assisted interventions will show significant improvements in cognitive, socio-emotional, behavioural, sleep and physiological measures comparing effects before and after intervention, and compared to children in the relaxation and no treatment control conditions.

b. The relaxation intervention will also show effects on measured outcomes before and after intervention, and compared to those in the no treatment control condition, however, it is expected to be less effective than the dog intervention.

c. Children in the no treatment control condition will show least or no improvements in measures. Any changes in this group will only come about via maturation and learning.

3. Intervention effects over time:

   a. There will be longitudinal improvements in children's cognitive, socio-emotional, behavioural and physiological measures.

   b. Immediate pre- to post intervention improvements will be stronger than longitudinal improvements.

4. Group and individual intervention sessions will lead to the same improvement in cognitive, socio-emotional, behavioural and physiological measures.

5. No gender differences are expected.

6. No effects for dog ownership are expected.

PART TWO: The current study

CHAPTER 5: Methods

5.1 Participants

A total of 119 children were recruited across 4 mainstream schools in Lincolnshire UK. N = 11 children were excluded before interventions began. Reasons for exclusions were as follows: absence due to bereavement (N = 1); special educational needs (N = 2); late sign-up (N = 4); parents withdrew due to questionnaire data requirements (N = 2) and not wanting children to miss certain classes during school day (N = 2). A sample of 108 children, N = 54 boys and N = 54 girls remained. A further 3 children missed baseline testing, and the final sample for data analysis including all longitudinal testing after 6 weeks, 6 months and 1 year contained a total of N=105 8-9-year-old children. The retention rate for this study lies at 97% with only 3% attrition.

There were only minor fluctuations over the longitudinal period, with N = 1 child who missed the post-test session after intervention due to illness, all children were present at the 6-week test session, N = 4 missed the 6-month test session; N = 1 had left school, N = 3 due to illness, and N = 4 missed the 1-year test session; N = 2 had left school, N = 2 due to illness..

Interventions were carried out as either one-to-one sessions or as a small-group-sessions. Those in control are also listed (see Table 3).

Participant characteristics: N = 6 children within the sample had prior diagnoses of either a developmental or medical disorder: Autism Spectrum Disorder (ASD) (N = 3), Autism Spectrum Disorder with Attention Deficit Hyperactivity Disorder (ASD & ADHD) (N =1), Epilepsy (N = 1) and Cystic Fibrosis (N = 1). In order to ensure an accurate picture of the data, all analyses were carried out with and without the inclusion of the six children who were diagnosed with a developmental or medical disorder. Differential effects did not emerge from the data therefore results are reported for all children across the study as part of attending mainstream schools, regardless of individual characteristics.

Table 3
Demographics and participation of all children included within each test time

Time of test	Condition	Session type	Age (yrs)		Gender		Overall
			M	*SD*	Boys	Girls	*N*
Pre-intervention	**All children**		**8.9**	**0.4**	**54**	**51**	**105**
	Dog	One-to-one	8.9	0.4	9	11	20
		Group	8.9	0.3	10	9	19
	Relaxation	One-to-one	8.9	0.5	11	9	20
		Group	9.0	0.4	7	11	18
	Control		8.8	0.4	17	11	28
Post-intervention	**All children**		**8.9**	**0.4**	**53**	**51**	**104**
	Dog	One-to-one	8.9	0.4	9	11	20
		Group	8.9	0.3	10	9	19
	Relaxation	One-to-one	8.9	0.5	11	9	20
		Group	9.0	0.4	6	11	17
	Control		8.8	0.4	17	11	28
6-week	**All children**		**8.9**	**0.4**	**54**	**51**	**105**
	Dog	One-to-one	8.9	0.4	9	11	20
		Group	8.9	0.3	10	9	19
	Relaxation	One-to-one	8.9	0.5	11	9	20
		Group	9.0	0.4	7	11	18
	Control		8.8	0.4	17	11	28
6-month	**All children**		**8.9**	**0.4**	**52**	**49**	**101**
	Dog	One-to-one	8.9	0.4	9	11	20
		Group	9.0	0.3	10	9	19
	Relaxation	One-to-one	8.9	0.5	11	8	19
		Group	8.9	0.4	6	10	16
	Control		9.0	0.4	16	11	27
1-year	**All children**		**9.0**	**0.4**	**54**	**47**	**101**
	Dog	One-to-one	9.0	0.4	9	11	20
		Group	9.0	0.3	11	8	19
	Relaxation	One-to-one	9.0	0.5	11	8	19
		Group	8.9	0.4	7	10	17
	Control		9.0	0.4	16	10	26

Please note: All test sessions administered by the experimenter at baseline (pre), post-intervention, 6-weeks, 6-months and 1-year time points are included within table 3 above. These include all cognitive, language and socio-emotional measures. Sample sizes for the following areas of data collection vary due to study design, for example, for obtaining salivary cortisol (e.g. only children in the intervention conditions provided acute cortisol), or for data that resulted from parental questionnaires (e.g. due to parental compliance in returning survey data).

Preparation:

- Pilot testing standardised measures, cortisol sampling and experimental tasks
- Recruitment of schools
- Recruitment of therapy dogs and handlers

Pre-intervention questionnaires and baseline measures:

Parents: Completion of consent forms, allergy & phobia information, dog ownership, wider demographics & EQ-SQ

Teachers: Class behaviour questionnaires

Children:

- Cortisol collection over three consecutive days
- Standardised and experimental tasks: Cognition, maths, language, anxiety, self-esteem, Stroop, categorization

Pre-intervention preparation:

- Familiarisation, children introduced to all dogs
- Safety training: Teaching children dog body language
- Children allocated to conditions: dog, relaxation, control

Interventions, 1st year one-to-one sessions:

- Dog and relaxation interventions: 20 minutes, twice per week over 4 weeks. Children acting as controls attend lessons as usual
- Acute cortisol collected at sessions 1, 4 & 8
- Sleep diary recorded at home over 4-week intervention

Interventions, 2nd year group sessions:

- Dog and relaxation interventions: 20 minutes, twice per week over 4 weeks. Children acting as controls attend lessons as usual
- Acute cortisol collected at sessions 1, 4 & 8
- Sleep diary recorded at home over 4-week intervention

Post-intervention questionnaires and standardised measures:

Parents: EQ-SQ

Teachers: Class behaviour questionnaires

Children:

- Cortisol collection over three consecutive days
- Standardised and experimental tasks
    - Cognition, maths, language, anxiety, self-esteem, Stroop, categorization

Longitudinal testing:

All questionnaires and standardised measures collected after 6-weeks, 6-months and 1-year test times

Figure 4. Longitudinal design: Preparation, testing and intervention sessions

5.1.1 Sample size: Salivary cortisol

Children across all three conditions (dog, relaxation and control) provided saliva for baseline measurement at the beginning and end of the school term. Only children taking part in the dog and relaxation conditions provided saliva samples for acute measures before and after intervention sessions one, four and eight (see Tables 4 -5). Whilst all children were encouraged to provide salivary cortisol, not all children were able to / assented to give saliva samples. Table 4 shows the number of samples provided per child which made up baseline samples. Final sample size for analysis was also reduced where it was not possible to analyse cortisol due to lack of saliva or abnormalities within samples.

Table 4
Demographics and sample size for collection of salivary cortisol

Sample type and collection time		Age (yrs)		Gender (N)	
	N (All)	*M*	*SD*	Boys	Girls
Baseline samples: pre & post intervention	90	8.9	0.38	43	47
Acute samples: intervention sessions S1, S4 & S8	47	8.9	0.43	20	27
Acute samples: intervention session S1	47	8.9	0.43	20	27
Acute samples: intervention session S4	67	8.9	0.41	32	35
Acute samples: intervention session S8	70	8.9	0.39	35	35

Note: Baseline and acute cortisol samples are only included where children had provided both pre and post intervention samples.

Table 5
Number of cortisol samples provided by children for baseline cortisol, pre- and post-intervention

Total samples provided for baseline measures of cortisol	No of children providing pre-intervention samples	No of children providing post-intervention samples
N = 1 baseline cortisol sample	3	4
N = 2 baseline cortisol samples	15	16
N = 3 baseline cortisol samples	78	74

5.1.2 Sample size: Sleep

Parents of N = 60, 8-9-year-old children (mean age = 8:8yrs, SD = 0.39yrs; N = 29 boys) completed and returned sleep diaries (see Table 6). Of these 60, 3 children's data was not included due to incomplete information.

Table 6
Demographics and participation of all children returning sleep diaries

Sleep diary data	Age (yrs)			Gender	
	N (All)	M	SD	Boys (N)	Girls (N)
All diaries returned	60	8.9	0.4	29	31
One to one intervention	44	8.84	0.39	25	19
Group intervention	13	8.94	0.39	3	10

5.1.3 Sample size: Empathy Quotient- Systemising Quotient (EQ-SQ).

Only children whose parents had completed the EQ-SQ questionnaires at both the pre and post intervention time points could be included within this analysis; N = 67, 8-9-year-olds (mean age = 8.9yrs, SD = 0.36); N = 35 boys (mean age = 8.9yrs, SD = 0.36), N = 32 girls (mean age = 8.9yrs, SD = 0.38yrs). Participant characteristics: N = 6 children within the sample had prior diagnoses of either a developmental or medical disorder: Autism Spectrum Disorder (ASD) (N = 2), Autism Spectrum Disorder with Attention Deficit Hyperactivity Disorder (ASD & ADHD) (N =1), Epilepsy (N = 1) and Cystic Fibrosis (N = 1).

5.1.4 Sample size: Parental report of 'Behaviour at home' questionnaire.

Only children whose parents had completed the Behaviour at Home questionnaires at both the pre and post intervention time points could be included within this analysis. Participants; N = 66, 8-9-year olds (mean age = 8.9yrs, SD = 0.37); N = 33 boys (mean age = 8.9yrs, SD = 0.35), N = 32 girls (mean age = 8.7yrs, SD = 0.39yrs).

5.2 Materials: Tasks, Administration and Data collation and analysis

In order to ensure consistency in presentation of methods across children and educational settings a research protocol was created for each data collection procedure carried out with pupils (see Appendix 1). Children first completed the self-esteem and anxiety measures, followed by the standardised cognition and language assessments using the British Ability Scales (BAS-3) and Assessment of Comprehension and Expression (ACE). Experimental tasks of Stroop, categorisation and maths were carried out last. Assessment using the BAS and ACE was rotated so that half of children did the BAS first, and half did the ACE first (see testing protocol at Appendix 1 for further details).

5.2.1 Cognitive Assessment: Standardised tests

The British Ability Scales (BAS-3) and the Assessment of Comprehension and Expression (ACE) were carried out as described below.

5.2.1.1 British Ability Scales (BAS-3) (2011)

Task: The British Ability Scales (BAS-3) (Elliot & Smith, 2011) is a school age test battery which was used to measure non-verbal reasoning ability and spatial awareness. The BAS-3 is designed to measure mental abilities that are significant for learning and educational performance. It is a standardised cognitive scale normed for use with children and adolescents aged from five years to seventeen years and eleven months. Importantly, each scale within the tool is separately normed in order that individual profiles of cognitive strengths and weaknesses can be gained. Individual scales used to assess each child within this study are: Matrices, Quantitative Reasoning, Recognition of Designs and Pattern Construction. These can be combined to create a global measure of cognition.

Test administration: The administration of the BAS was carried out by the researcher, and answers recorded on standardised scoring sheets. The BAS required that all children started each task at the appropriate level for their age. There was no set cut-off for completion of testing. All children finished at the end of different subsections depending on their ability to answer the questions correctly. Assessment would end when children got three consecutive answers wrong within any given subsection. This allowed higher ability children to score higher scores so as long as they were able to perform the tasks effectively. Specific instructions given to children when administering the task can be found in the testing protocol at Appendix 1.

Data collation and analysis: Children scored one point for each question answered correctly. These scores were then converted to standardised scores using an online scoring system based on the age of the child, the date of the test and the level of their performance. Standardised scores were acquired for each cluster of measures (see Table 7).

Table 7

British Ability Scales (BAS): Breakdown of test battery used

Cluster measure	Cluster measure	Specific task	Abilities measured
Special Non-verbal Composite (SNC)	Non-Verbal Reasoning Cluster	Matrices	Inductive reasoning: identification and application of rules governing relationships among abstract forms.
		Quantitative reasoning	Inductive reasoning: detection and application of rules for sequential patterns and relationships between pairs of numbers
	Spatial Cluster	Pattern construction	Non-verbal reasoning and spatial visualisation in the reproduction of designs with coloured cubes.
		Recognition of designs	Short-term memory for geometric forms.

5.2.1.2 The Assessment of Comprehension and Expression (ACE)

<u>Task:</u> *The Assessment of Comprehension and Expression (ACE)* (Adams, Cooke, Crutchley, Hesketh & Reeves, 2001) is used to assess language comprehension. The ACE is designed to identify delayed or impaired language development in children between six to eleven years. The toolkit allows standard scores, percentile ranks and confidence bands for each subtest making it a flexible tool ideal for the assessment of individual children. Individual subscales used within this study were the sentence comprehension and syntactic formulation tests.

<u>Test administration</u>: The administration of the ACE was carried out by the researcher, and answers recorded on standardised scoring sheets. The ACE required that all children complete all questions within each subsection, and ended when the child got to the end of each subsection. Children were required to answer questions by indicating from a choice of four pictures. Specific instructions given to children when administering the task can be found in the testing protocol at Appendix 1.

<u>Data collation and analysis</u>: Correct answers received either one or two points depending on the requirements of the subsection being completed. These were totalled at the end of the section to provide a cluster score for each task (see Table 8). These totals were then converted to standardised scores using the ACE scoring manual based on the age of the child when the assessment was completed.

Table 8

Items from the Assessment of Comprehension and Expression (ACE) toolkit, used to test language profiles of children within the current study

Task	Domain
Sentence comprehension	-Ability to decode specific verbal concepts, time and emotion in sentences.-Ability to decode sentences of increasing length and syntactic complexity.
Syntactic formulation	-Ability to formulate sentences based on specific vocabulary.- -Ability to formulate sentences of increasingly complexity

5.2.2 Cognitive Assessment: Experimental tasks

A maths task, a Stroop task, and a categorisation task were carried out as described below.

5.2.2.1 Maths

Task: A short maths task using arithmetical problems was created based on an example used to assess children at the end of Y4 (8-9 years) within schools. Children were not yet at this point in their education and so the task was designed to be difficult. The task consisted of 20 questions, broken into 5 types of task. Task 1 consisted of addition of either two or three digit numbers with a missing value (example: 40+50____+40 =130). Task 2 were subtraction of either three or four digit numbers (example: 310-160 =__). Task 3 consisted of column subtractions of three digit minus two digit numbers (example 634 -77+__). Task 4 were multiplication and division, these always consisted of values 6, 7, 8 & 9 and answers would be two digit in nature (examples: 7x8=__, 64÷8 =__). Task 5 involved multiplication of a three digit and a one digit number (example: 376 x8 =__).

Test administration: Children were given the maths task as a pen and paper exercise. Children were told that they had 2 minutes to complete as many of the questions as possible and that they could use the paper to do any working out to help them solve the maths problems. The task was timed and ended when two minutes had elapsed. Based on the number and difficulty of the questions, children were not expected to complete the full battery of questions within 2 minutes.

Data collation and analysis: Children scored one point for each correctly answered maths problem. These were then totalled for number answered correctly in two minutes. These raw scores were used to analyse the final dataset.

5.2.2.2 Fruit Stroop

Task**:** The Fruit Stroop task was based on the method applied by Okuzumi et al., (2015) and consisted of line drawings of three types of fruit; banana, strawberry and pear. Children were given the fruit stroop task as a pen and paper exercise. The Stroop task (Stroop, 1935) is a useful measure of mental processing and is particularly sensitive to aspects of attention. The method is based on the principle that certain cognitive skills share the same mental processes, creating a conflict for attentional processing. During the Stroop task, dominant responses must be inhibited in order to perform the incongruent task well, thus providing a measure of inhibition. The Fruit Stroop version was specifically used in order to reduce the impact of language capabilities but still assess a measure of interference during cognitive processing. Children were required to complete three separate Fruit Stroop tasks; congruent blank (CB), incongruent colour (IC), neutral colour task (NC) (control).

Test administration CB: The congruent blank (CB) task involved children being presented with line drawings of fruit alongside the canonical colours of the fruit (strawberry = red, banana = yellow, pear = green) placed at random in three columns to the right of the drawings. Children were required to tick the appropriate colour associated with the blank fruit as quickly and as accurately as possible.

Test administration IC: The incongruent colour (IC) task involved children being presented with incongruently coloured drawings of fruit alongside the canonical colours of the fruit (strawberry = red, banana = yellow, pear = green) placed at random in three columns to the right of the drawings. Children were required to tick the appropriate colour associated with the wrongly coloured fruit as quickly and as accurately as possible.

Test administration NC: The neutral colour (NC) task was made up of shapes (square, circle and triangle, coloured in the canonical colours associated with the fruit in the other conditions), alongside the colours of the shapes placed at random in three columns to the right of the drawings. Children were required to tick the appropriate colour associated with the blank fruit as quickly and as accurately as possible.

Data collation and analysis Fruit Stroop task: Each correct answer from the CB, IC and NC tasks scored one point and total scores were calculated for each. Interference scores for each task were then calculated using the following formulas in Table 9.

Table 9
Calculation of interference scores for Fruit Stroop Task

Analysis	Fruit Stroop tasks calculated	Formula for interference and SOP scores
Congruency	Congruent & Incongruent fruit	100* (CB – IC) / CB
Colour congruency	Neutral shape & Incongruent fruit	100 * (NC – IC) / NC
Speed of Processing (SOP)	Congruent, Incongruent fruit & Neutral shape	(IC + CB + CC) / 3

Note: Congruency: Negative values indicate interference and higher scores reflect better performance on the task. SOP: Number of items completed per second therefore higher values represented faster processing.

5.2.2.3 Categorisation task

Task: The categorisation task was based on the method applied by Gee, Gould, Swanson & Wagner (2012b). Images were chosen to represent scenes belonging the categories ‘farm and ‘ocean’; within these groupings, images were also chosen to fit into two further categories; animate vs inanimate and typical vs atypical images. Four distinct categories exist within each category: typical-animate, atypical-animate, typical-inanimate, and atypical-inanimate. Images were prepared using Adobe Photoshop Elements 6.0. The 600 x 450pixel jpeg images were placed on a 5% greyscale background. All images were previously rated for animacy by students at the University of Lincoln (N = 32) using online recruitment and data collection through Qualtrics.

Test administration: All instructions and images were presented through Superlab Version 5 and collected data saved within the program. The Superlab program was presented on a 15” laptop with an Intel® Pentium® CPU 3825U @1.90GHz at a size of 16”, at a viewing distance of approximately 70cm. Children made their choices through a Cedrus serial button port using two buttons only. These were coloured blue for seaside and green for farm. The program was designed so that a button press response by the child initiated the presentation of the following image. This continued until all 48 images had been sorted by the child.

Data collation and analysis: Children’s scores were based on speed-reaction time measurements, whereby children’s time to decide on the categorical properties of each image was recorded in milliseconds. Scores for animacy were assessed separately.

5.2.3 Self-Esteem and Anxiety: Standardised assessments

The Culture Free Self-Esteem Inventory (CFSEI-3) and Revised Children’s Manifest Anxiety Scale (RCMAS-2) were carried out as described below.

5.2.3.1 The Culture Free Self-Esteem Inventory (CFSEI-3)

Task: The Culture Free Self-Esteem Inventory (CFSEI-3, (Battle, 2002) was used to assess each child’s level of self-esteem. The CFSEI is a standardised self-report measure of self-esteem for pupils’ ages 6:00 to 18:11 years.

Test administration: The CFSEI-3 was administered to children by the researcher, and required simple yes/no answers from the child.

Data collation and analysis: Children scored one point for each question which represented a positive measure of self-esteem. Total scores gave a measure of children’s self-esteem comparative to other children.

5.2.3.2 Revised Children's Manifest Anxiety Scales: Second Edition (RCMAS-2)

Task: The Revised Children's Manifest Anxiety Scales: Second Edition (RCMAS-2) is used to assess the level of each child's anxiety. The RCMAS-2 is a standardised measure of anxiety requiring yes/no answers. The self-reported measure is suitable for ages six to nineteen years of age. The short form of the test was used for the purposes of this project and comprised of 10 questions (Reynolds & Richmond, 2008).

Test administration: The RCMAS-2 was administered to children by the researcher, and required simple yes/no answers from the child.

Data collation and analysis: Children received one point for each answer representing a measure of anxiety, children could score between 0 (no anxiety) and 10 (high anxiety).

5.2.4 Teacher and parent questionnaires

Teachers completed the Child Behaviour Rating Scale (CBRS). Parents completed a 'behaviour at home questionnaire', the Empathy/Systemising Quotient (EQ-SQ), a 'family background & pet ownership questionnaire' and a sleep diary. These were carried out as described below.

5.2.4.1 The Child Behaviour Rating Scale (CBRS)

Task: The Child Behaviour Rating Scale (CBRS), (Bronson, Goodson, Layzer & Love, 1990) was used to assess children's behaviour within the classroom setting. The CBRS is a multi-dimensional assessment of children's school readiness, self- regulation and social skills.

Test administration: A teacher with experience of the child was required to complete the 17 item questionnaire which is comprised of 10 items assessing self-regulation and 7 items assessing social skills.

Data collation and analysis: The completed scale gives a final score of the child's classroom behaviour, with higher scores representing better self-regulation and social skills.

5.2.4.2 Family background and Pet ownership questionnaire

Task: Parents were asked to complete the questionnaire at the start of the study and again after interventions had taken place. The family background and pet ownership questionnaire comprised of 50 questions in total and was specifically created for data collection on the project. The family background questionnaire consisted of 27 questions and collected demographic data on the number of people in the household, number of siblings, parental education, occupation and income. The pet ownership questionnaire consisted of 23 questions and collected data in relation to pet ownership, the number and type of pets in the family, as well as experience with dogs and dog bite information (see appendix 2).

Test administration: Parents could choose to complete either electronic copies via Qualtrics or could have paper copies sent home through school. Parents were encouraged to participate by being provided with a £5 high street shopping voucher for the return of completed information.

Data collation and analysis: Demographic data was scored and coded within SPSS.

5.2.4.3 Child behaviour at home questionnaire

Task: Parents were asked to complete the questionnaire at the start of the study and again after interventions had taken place. The child behaviour at home questionnaire consisted of 18 questions and asked parents to rate the current behaviour of their child. It was created for data collection within this research project and specifically collected data on three areas of interest, namely co-operative behaviour at home, attitudes towards school and general socio-emotional behaviours (see Appendix 3).

Test administration: Parents could choose to complete either electronic copies via Qualtrics or could have paper copies sent home through school. Parents were encouraged to participate by being provided with a £5 high street shopping voucher for the return of completed information.

Data collation and analysis: Scores were measured on a Likert scale ranging from 1(never) to 5 (always). Higher totalled scores represented better standards of child behaviour.

5.2.4.4 Empathy Quotient-Systemising Quotient (EQ-SQ) (Child)

Task: The EQ-SQ (Child) (Auyeung et al., 2009) is a 55-part questionnaire designed to measure a child's tendency towards both empathising and systemising. The 55 items offer four alternatives for each question and requires completion by a parent.

Test administration: The parent indicates how strongly they agree with each statement about their child by ticking one of several options: 'definitely agree', 'slightly agree', 'slightly disagree', or 'definitely disagree'.

Data collation and analysis: The 55-part questionnaire is made up of 27 EQ related statements and 28 SQ related statements. Scores were totalled for both EQ and SQ separately with maximum scores for the EQ section being 54, and 56 for scores relating to SQ. Higher scores represented more systemising / empathising behaviours.

5.2.4.5 American Academy of Sleep Medicine (ASSM) Sleep Diary

Task: Data in relation to sleep was collected through the American Academy of Sleep Medicine (ASSM) sleep diary The diary was a pen and paper self-report instrument designed for recording sleep patterns in a simplified manner.

Test administration: Parents were asked to complete the diary with their child in order to reduce errors in record keeping. Families were asked to complete over the four weeks that

interventions were taking place. In order to encourage participation in completing the sleep diaries at home, a small LED alarm clock was offered in return for completed sleep diaries.
Data collation and analysis: Scores were calculated for sleep efficiency by dividing the number of hours a child spent in bed, by the number of hours they slept. Higher scores represented poorer sleep efficiency.

5.2.5 Physiological measurement

Salivary cortisol collected through passive drool was carried out as described below.

5.2.5.1 Salivary cortisol

Task: All saliva collection, handling and storage was carried out in accordance with Salimetrics LLC Saliva Collection and Handling Advice (2015). A protocol for the consistent collection of salivary cortisol was created for the project (see appendix 4).
Test administration: Collection of salivary cortisol was carried out using the passive drool method. All samples were assigned a unique bar code and paired with a child. No child details were included with any samples and so these were anonymised at all times. Children were asked to spit directly into 3.5 ml cryovials, until at least 1ml of saliva was collected. Each cryovial was immediately capped and placed onto ice blocks in a pathology bag to keep all samples cool until they could be frozen in the lab at -23^{o}. The amount of time that batches of samples were kept on ice varied, depending on the research activities being carried out in the school and the location of the school in relation to the lab, but this was generally between 1 and 4 hours.

Three baseline samples were collected for each child over three days before interventions began. These were taken between 9.30 and 10.15am over three consecutive mornings. Three consecutive samples were then taken again after the last intervention session to gain a further comparison sample after 4 weeks. Baseline saliva samples were collected from children taking part in all conditions; dog, relaxation and control.

Acute salivary cortisol was collected on sessions 1, 4 and 8 of the intervention timetable. Each child gave a saliva sample immediately before taking part in either the relaxation or dog intervention sessions and then a further sample approximately 30 minutes after each intervention session had ended. In this instance children in the control group did not provide cortisol samples. All samples were stored in a locked lab freezer (located in the Infant & Child Development Lab; University of Lincoln) at -23° for a maximum of 7 days. Samples were then shipped to Anglia Ruskin Biomarker Analysis Laboratory, UK, for storage until analysis. Samples were transported in line with UN3373; were triple packed on dry ice, labelled "Human Saliva Samples-Biological Substance Category B- UN3373" and contained a manifest of all barcode samples enclosed. No samples were kept for further use - all samples were destroyed immediately after analysis by the Anglia Ruskin Biomarker laboratory.

<u>Data collation and analysis:</u> All samples were assayed for salivary cortisol using a high sensitivity enzyme immunoassay (Salimetrics Europe Ltd). 10 % of samples were assayed in duplicate. If the coefficient of variation for the concentration between the duplicate repeats was greater than 15% then saliva samples were re-run unless absolute values between the first and second samples were within 0.03µg/dL.

<u>Salivary cortisol data analysis</u>: Sample data were collated in Microsoft excel and assessed for outliers. Any single sample data points found to be less than or greater than 2.5SDs from the mean (µg/dL) were removed. This resulted in one baseline sample and one pre- intervention acute sample from session 4 to be removed. One child's data was removed due to high samples across the whole study, which was related to steroid medication, and a further two children were removed due to refusal to give samples after the first saliva collection session.

Average baseline and post-intervention totals were calculated from the remaining samples. Most children provided three samples before and after intervention successfully, however, some children's cortisol scores had to be taken from less than three samples (see Table 4 above).

5.3 Ethics, safety and welfare

5.3.1 Ethical approvals

The research project was approved by the Mars/Waltham Research Ethics Committee and by the University of Lincoln Psychology Research Ethics Committee (soprec@lincoln.ac.uk) and is in line with the British Psychological Association (BPS) Guidelines (see Appendix 5 for Ethics approval forms). The researcher had an enhanced DBS check and is highly experienced in carrying out research with children in schools. All dog handlers volunteering on the project were required to have an enhanced DBS check (see Appendix 5).

5.3.2 Safety and Welfare considerations

The project worked with Pets as Therapy to recruit dogs and handlers. All dogs were re-assessed by a second independent canine behaviourist in order to ensure suitability of the dogs to interact with children within school settings. All handlers were required to attend safety training on dog stress signalling behaviour prior to inclusion on the project. Dog Welfare plans were created in order to ensure that all handlers and researchers maintained high standards of welfare for all dogs taking part in interventions. Dogs were required to work no more than two hours in any one session per day, although most sessions were usually one hour and twenty minutes per dog. Dogs had a short break every 20 minutes as children were moved between the intervention room and their classroom. Dog handlers were free to take the dog outdoors for a break as required, water was available at all times and the dogs were provided with their own bedding in the room in order to have ‘time out’ as they required. The intervention would be stopped if the dog showed signs of discomfort or being tired. A comprehensive risk assessment was also created for schools in order to ensure high standards of health and safety of dogs, handlers, children and school staff (Brelsford, Dimolareva, Meints & Gee, 2018). Strict protocols for initial visits to schools by dogs were created in order to reduce potential stressful effects on dogs in an unfamiliar environment (see appendix 6 for welfare plan & risk assessment). School staff and children were trained on dog body language and safe behaviour with dogs.

5.3.4 Dogs and handlers

Eight different dogs and their handlers took part in the interventions on a volunteer basis. Dogs included a Greek Hare-Hound (neutered male; 3yrs), Cavalier King Charles Spaniel and Miniature Poodle crossbreed (spayed female; 3yrs), Labrador and miniature Poodle crossbreed (spayed female; 9yrs), two German Short Haired Pointers (neutered male; 2yrs) (unneutered male; 10yrs), two Miniature Schnauzers (spayed females; 10yrs) and Labrador (neutered male; 2yrs). Volunteers and their dogs were insured through Pets as Therapy, a registered charity providing animal-assisted therapy within community settings. One handler and their dog was insured separately.

5.4 Procedure

5.4.1 Recruitment

All recruitment took place in mainstream schools in Lincolnshire, UK. Due to the intensity and length of the present study, schools were recruited through Head Teachers in the first instance in order to ensure a wider understanding of the project and to gain the long-term commitment of the school. Children were then recruited through letters sent out to parents of the recruited schools. All letters were approved and were in line with the ethical protocols and guidelines above.

Recruitment letters presented parents with an overview of the study, its aims and more detailed information surrounding the collection of physiological measures of cortisol through saliva and information of all measures undertaken. Parents were asked to declare any pet allergies or phobia, and were made aware of the questionnaire data they would be asked to provide as part of the data collection process. They were asked to complete the consent form for themselves and their child to take part and to return to school (see Appendix 7 for copy of letter and consent form). Children were asked for their assent before starting all assessments and intervention sessions.

5.5 Design

This study is a longitudinal, randomised control trial design. Stratified randomisation was used to allocate children into the dog, relaxation or control conditions based on four factors: dog ownership, gender, academic ability and family socio-economic status, so that all groups were as equally as possible represented across all conditions.

5.5.1 Baseline cortisol

Baseline cortisol samples were obtained over 3 consecutive days at the beginning of the study and before any other research activities began in school.

5.5.2 Safety training and familiarisation

After the last cortisol samples were taken, and prior to intervention sessions, all children took part in safety training on understanding dog body language and safe behaviour with dogs this included an interactive presentation followed by a question/answer session. All children were familiarised with all dogs prior to intervention in order to eliminate potential novelty effects. Familiarisation sessions took place in the week preceding intervention, with approximately 30 minutes exposure to each dog in small group sessions. Children were introduced to the dog and given some general information such as breed, sex, age, likes and dislikes by the handler. Children were then encouraged to ask questions in order to gain familiarity with each dog. Children were allowed to pet the dog as it was led around the group by the handler. This was only done once the researcher and handler agreed that the dog was relaxed and showed no signs of stress. All children remained seated during these sessions. The handler was briefed by the researcher if any children had anxieties around meeting the dog. Any child worried about meeting the dog were not forced to take part, however anxious children who did want to join in were purposely seated next to the researcher and the greeting process was child-led. No child was made to stroke or interact with any dog if they did not feel comfortable in doing so and the handler did not approach them with the dog unless they requested it (see Appendix 8). Before beginning intervention sessions with the dogs, the children also took part in a do’s and don’ts activity. This took approximately 2 minutes and aimed at setting clear boundaries for behaviour around the dogs during sessions, in addition to reducing the potential for unnecessary risk, for example children crowding the dog. This also ensured that children understood the welfare needs of the dogs and the requirement to uphold these at all times (see Appendix 9).

5.5.3 Baseline assessments

Children then took part in baseline assessments individually with the researcher which took approximately one hour per child. Eleven separate tests were administered to each child (see section 5.2 above). In order of administration, these were the Revised Children’s Manifest Anxiety Scales (RCMAS-2) (2008); the Culture Free Self-Esteem Inventory (CFSEI-3)

(2002); British Ability Scales (BAS-3) (2011) subscales Matrices, Quantitative Reasoning, Recognition of designs and Pattern construction; Assessment of Comprehension and Expressions (ACE, 2002) subscales of Sentence comprehension and Syntactic formulation; a categorisation task, a Fruit Stroop task and a maths test. Specific administration instructions for all tests can be found in Appendix 1.The order of administering the BAS and ACE standardised tests was counterbalanced across children to limit against order effects, with half doing the BAS first and half doing the ACE first. Each child's order of testing remained the same across the length of the study. An average of 21 children per week were assessed on baseline measures, followed by 4 weeks of intervention, followed by repeat assessment of the same children in the following week. Due to the duration of testing required to complete the study and the length of the school terms, and addition to potential effects of Seasonal Affective Disorder testing of children was carried out in waves rotated across schools, with 1/3 of each tested on dog intervention, 1/3 on relaxation intervention, and 1/3 as a no treatment control.

5.5.4 Intervention sessions

Following baseline assessments, children took part in four weeks of either dog or relaxation intervention for 20 minutes, twice per week. Those in the control group continued with normal class lessons. In order to assess whether differences exist between individual and group interventions, two different types of session were also carried out; one-to-one sessions or small group sessions. After interventions were completed, all children then completed the battery of assessments again (immediate follow-up after 4-week intervention). All children then took part in three further test sessions to assess longevity of the interventions. These took place six weeks after intervention ended, at six months after intervention ended and one year after intervention had ended. The following Figure 4 shows this in overview:

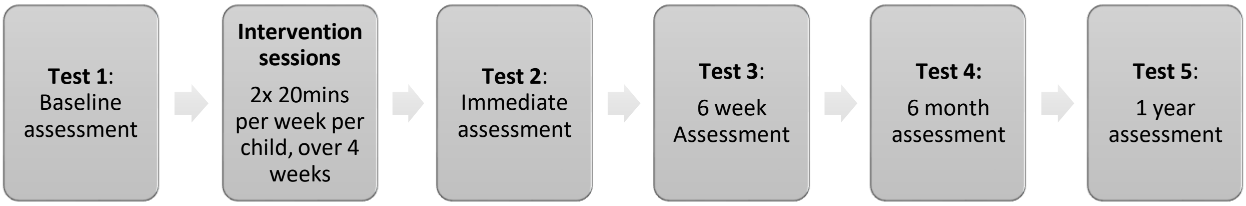

Figure 5: Pre-post assessment points and intervention session timeline

5.5.4.1 Dog-Assisted Intervention

Each intervention session lasted for 20 minutes. It began and ended with the child actively greeting/saying goodbye, petting the dog as appropriate. The central part of the session was based around the dog with children learning facts about the dogs from the handler, talking about and interacting with the dog. This was very much child-led and all sessions varied in content. All intervention sessions with dogs were video recorded using a GoPro HERO4, 1080p, 720p, 12mp action camera. After interventions had ended children were thanked and asked to return to their classrooms.

5.5.4.2 Relaxation intervention

Relaxation sessions consisted of two different recordings from Enchanted Meditations for Kids (Kerr, 2005). Version 1 consisted of the “Jellyfish” relaxation and version 2 consisted of the “Butterfly” relaxation. The two separate recordings were played alternately over the length of the 8 sessions: each child being exposed to each recording 4 times.

Individual ‘sessions’ were stitched together using Audacity 2.1.2 (1991) in order that the sessions ran back-to-back without a silence so as not to disturb the relaxed state of the child and ensuring that the session ran within the allocated timescale of 20 minutes. Sessions were designed for similarity with the dog interventions, and consisted of approximately 5 minutes active relaxation, including breathing and muscle exercises, followed by meditation for 10 minutes and then a further 5 minutes of active relaxation. Each session lasted for 20 minutes and children were required to lie down and listen to the tape until it had finished. Children who were uncomfortable with lying down, were allowed to sit with their eyes closed instead. After intervention, children were asked to get up quietly, thanked and asked to return to their classrooms.

5.5.4.3 Control group

Children assigned to the no treatment control condition took part in their regular lessons.

PART THREE: Results

CHAPTER 6. Effects of AAI on children's cognition

6.1 Measures overview for non-verbal cognition tasks

As described above, research on AAI and specific cognitive processes such as spatial, and non-verbal reasoning, attention, executive processing, and speed reaction time tests have not been tested rigorously. The current study examined the effect of AAI on cognitive processing through the British Ability Scales (BAS-3) as standardised test of cognition, in addition to the Fruit Stroop and a maths task. BAS-3 tests included visual short term memory and perceptual matching tasks combined to measure children's spatial ability (SA). Non-verbal and quantitative reasoning tasks combined to measure children's non-verbal reasoning ability (NVR). SA and NVR are then combined to inform a measure of Special Non-verbal composite (SNC) which represents a global measure of cognition (see Chapter 5 for further details of measures).

Whilst pattern detection and spatial visualisation skills were tested through the standardised tests in the British Ability Scales (see above), it is also important to assess a task that children are familiar with which employs these abilities in a practical application. The ability to apply learnt information in a flexible manner is a key feature of executive function (Diamond, 2013). As patterning and spatial skills contribute to the development of numeracy (Rittle-Johnson, Zippert & Boice, 2018) , the current study tested children's mathematical ability in the same way as they are typically assessed in school - by asking children to solve problems which required flexible use of knowledge to solve subtraction, multiplication, addition and division problems.

Inhibitory control is an important feature of executive function, allowing the child to control behaviour, thoughts and emotions (Diamond, 2013). One way in which to assess inhibitory control is through the Stroop task. The current research project will test inhibitory control using the ‘Fruit Stroop’ (Okuzumi, 2015), this task was chosen because as well as testing the child’s ability to suppress information in order to process the task effectively, it also measures children’s reaction times and links with wider classroom behaviour.

6.1.1 Data management, structure and analysis of cognition results

Cognitive abilities were measured using the standardised BAS-3. The global measure of non-verbal cognition was first analysed using the Special Non-Verbal Composite (SNC) which consisted of non-verbal reasoning (NVR) scores and spatial ability (SA). The SNC was then broken down further and analysed separately as NVR (which consisted of non-verbal and quantitative reasoning tasks) and SA (which consisted of visual short term memory and perceptual matching tasks).

Firstly, scores were calculated for all children, including those who took part in one-to-one and group intervention sessions. Descriptive statistics were reported followed by repeated measures analysis of variance. Data was first analysed to test for potential differences in scores between schools using one way analysis of variance (ANOVA) before running repeated measures ANOVAS for all children on the effects of Time x Condition (dog / relax / control) x Gender (boys/girls) x Dog ownership (dog owner/ non-dog owner), with repeated measures on the factor of time.

Secondly, to investigate the effects of AAI further, data was then analysed in more detail depending on whether children took part in one-to-one interventions or within a small group. Planned comparisons were conducted using paired samples t-tests and post-hoc tests conducted as appropriate throughout. All results were adjusted using Bonferroni corrections.

6.2 Results: Special non-verbal composite (SNC), non-verbal reasoning (NVR) and spatial ability (SA)

Inspection of the pre-intervention data using the Shapiro-Wilk test revealed that assumptions of normality are not violated for any of the baseline BAS measures; Global SNC (W = .990 p = .656), NVR (W= .978, p = .077), SA (W= .992, p = .797). Parametric tests will therefore be applied for analysis of the BAS data.

6.2.1 All children: Special Non-Verbal Composite (SNC) (Global cognition)

All children's SNC scores increased to the 6-week test time, apart from girls who had a dog at home who only showed an increase to post-intervention. SNC scores at the 6-month and 1-year test times are less consistent across groups in terms of improvement. All children's SNC scores show an increase between baseline and the 1-year tests. Dog-ownership status was unequal across gender, with one third of boys having a dog at home, compared with equal numbers of girls. The following tables 10-12 show the results by intervention condition.

Table 10
Mean and standard deviation data for children's SNC scores in dog intervention, split by gender and dog ownership dempgraphics

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	6	90.000	13.236
		Post-intervention	5	98.000	15.652
		6-week	6	104.16	12.624
		6-month	6	97.500	13.605
		1-year	5	92.500	12.849
	No dog	Pre-intervention	13	86.846	15.592
		Post-intervention	13	92.461	21.073
		6-week	13	96.461	21.254
		6-month	13	98.384	23.311

		1-year	13	95.230	18.877
Female	Dog	Pre-intervention	12	87.750	14.155
		Post-intervention	12	93.083	19.420
		6-week	12	97.000	18.488
		6-month	12	94.750	18.849
		1-year	12	92.166	15.925
	No dog	Pre-intervention	8	91.375	13.059
		Post-intervention	8	96.625	14.242
		6-week	8	101.750	16.900
		6-month	7	101.714	16.204
		1-year	7	107.285	19.241

Table 11
Mean and standard deviation data for children's SNC scores in relaxation intervention, split by gender and dog ownership demographics

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	8	95.750	17.637
		Post-intervention	8	102.375	14.725
		6-week	8	105.250	13.123
		6-month	7	105.000	19.192
		1-year	8	103.750	14.858
	No dog	Pre-intervention	10	93.400	16.547
		Post-intervention	9	100.333	19.274
		6-week	10	104.500	15.277
		6-month	10	101.100	16.072
		1-year	10	105.900	19.278
Female	Dog	Pre-intervention	8	92.750	4.241
		Post-intervention	8	93.375	24.465
		6-week	8	101.875	23.215
		6-month	7	99.500	19.486
		1-year	7	94.857	17.639
	No dog	Pre-intervention	12	86.666	14.840
		Post-intervention	12	90.333	13.566

		6-week	12	94.916	17.406
		6-month	11	85.727	31.965
		1-year	11	93.363	17.505

Table 12

Mean and standard deviation data for children's SNC scores in control condition, split by gender and dog ownership demographics

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	4	101.750	18.391
		Post-intervention	4	101.750	16.918
		6-week	4	104.750	17.914
		6-month	4	107.000	21.244
		1-year	4	105.750	18.962
	No dog	Pre-intervention	13	97.538	15.234
		Post-intervention	13	103.846	13.520
		6-week	13	106.076	14.366
		6-month	12	103.250	16.465
		1-year	12	109.461	23.655
Female	Dog	Pre-intervention	4	106.000	14.696
		Post-intervention	4	111.250	10.781
		6-week	4	109.750	3.774
		6-month	4	105.750	6.800
		1-year	4	112.000	10.230
	No dog	Pre-intervention	7	90.142	8.474
		Post-intervention	7	94.428	14.316
		6-week	7	96.285	11.426
		6-month	7	95.142	12.575
		1-year	6	95.166	2.172

An initial one-way ANOVA was conducted to assess whether data collection through the BAS at baseline was different across schools. No significant effects of school were returned in relation to each of the tests; SNC [F (3, 104) = 1.99, p = .119, η_p^2 =.056], NVR [F

(3, 104) = 1.834, p = .146, η_p^2 =.052], SA [F (3, 104) = 1.355, p = .261, η_p^2 =.039] showing that test scores were not different based on school attended. The data was therefore collapsed over schools for further analysis.

A 5 (Time) x 3 (Condition) x 2 (Gender) x 2 (Dog ownership) analysis of variance with repeated measures on the factor of time, was conducted to assess the effect of intervention condition on children's global non-verbal scores (SNC). Data met assumptions of sphericity; Mauchly's (W (9) = .917, p = .623). A highly significant main effect of time [F (4, 336) = 25.483, p < 0.001, η_p^2 =.233] showed that children's SNC improved over the school term, with time explaining a high degree of variance within the model. Planned comparisons for the factor of time showed a significant increase in children's SNC scores up to the 6-week test time (Table 13).

Table 13
SNC, planned comparisons for significant main effect of time (Bonferroni: p = .0125)

SNC, paired samples by time	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Pre-post intervention	-4.99	8.42	-6.012	102	.000
Post-intervention to 6-week	-4.00	7.37	-5.502	102	.000
6-week to 6-month	1.69	8.77	1.925	99	.057
6-month to 1-year	-0.37	9.59	-.390	97	.698

No main effect of condition [F (2, 84) = .896, p = .412, η_p^2 =.021] or interaction of time with condition [F (8, 336) = 1.525, p = .147, η_p^2 =.035] were revealed. As the crucial question was whether dog-interventions had an effect on children's scores before and after intervention, planned comparisons were conducted. Comparison from baseline to the 1-year test time showed that all children in all conditions made significant improvements in SNC scores; dog (t (37) = -4.933, p < .001), relaxation (t (36) = -6.290, p < .001) control (t (25) = -3.646, p = .001). Assessment of performance between each consecutive test time, per condition, showed that children in the control condition made no significant increase in SNC scores between any of the consecutive test times, but as predicted, those in the dog (t (37) = -4.012, $p < .001$) and relaxation conditions (t (37) = -3.250, $p = .002$) made significant improvements between the pre- and post-, and the post-intervention and 6-week tests (dog (t (37) = -4.922, $p < .001$); relaxation (t (37) = -3.821, $p < .001$). No other consecutive test times reached significance for any condition. (see Figure 6).

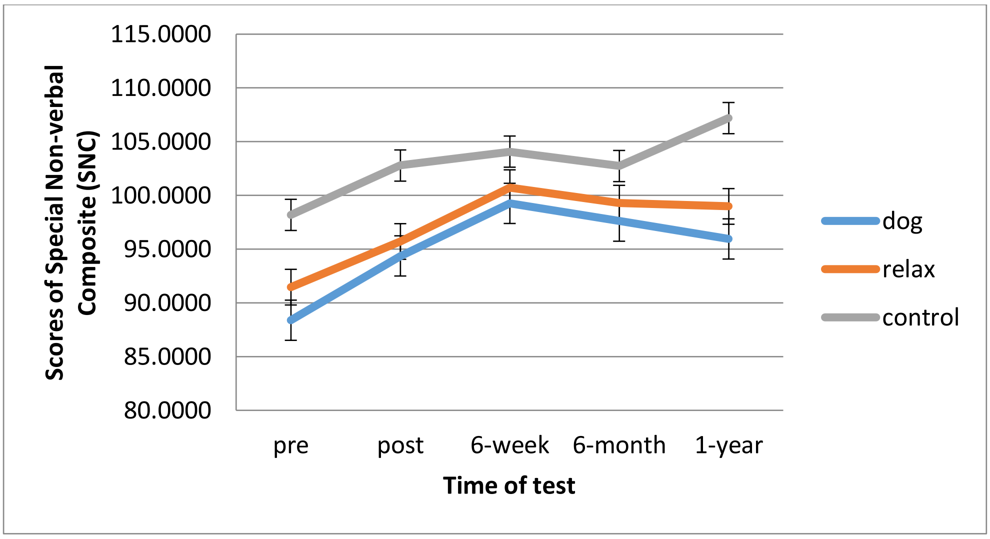

Figure 6. SNC: Planned comparisons for condition over time (Bonferroni: $p = .004$)

No further significant main effects or interactions were present within the analysis. As no effects of gender or dog ownership were found within the SNC data, these are excluded from further analysis to assess the effect of session-type (one-to-one and group interventions).

The following results for one-to-one and group sessions are presented together. For each analysis a (5 (Time) x 3 (Condition) analysis of variance with repeated measures on the factor time was conducted on children's global non-verbal scores (SNC); violation of sphericity was tested and corrections used as appropriate (see Appendix 10).

6.2.1.1 One-to-one sessions: Special Non-Verbal Composite (SNC)

A highly significant main effect of time on SNC was revealed [F (4,240) = 21.112, p < .001, η_p^2 = .260] with time explaining a high degree of variance within the model. Planned comparisons showed that children's scores improved significantly up to the 6-week test time (see Table 14).

Table 14
SNC, one-to-one intervention sessions: planned comparisons for significant main effect of time (Bonferroni: p =.0125)

SNC, paired samples by time	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Pre-post intervention	-6.176	7.949	-6.407	67	.000
Post-int. to 6-week	-2.294	6.687	-2.829	67	.006
6-week to 6-month	0.661	8.948	0.596	64	.553
6-month to 1-year	-0.619	10.565	-10.465	62	.644

No significant main effect of condition [F (2, 60) = 2.042, p = .139, η_p^2 = .260] or any interaction with condition were revealed [F (8, 240) = 1.638, p = .115, η_p^2 = .052]. Comparisons of results between the baseline and 1-year test time showed that children in the dog (t (19) = -3.584, p = .002), relaxation (t (18) = -5.201, p < .001) and control conditions (t (25) = -3.646, p =.001) all made significant improvement in SNC over the length of the study. Planned comparisons over consecutive times showed that the only children who made a highly significant improvement in SNC scores were those in the one-to-one dog condition between the pre- and post-intervention test times (t (19) = -5.328, p < .001) (see Figure 7).

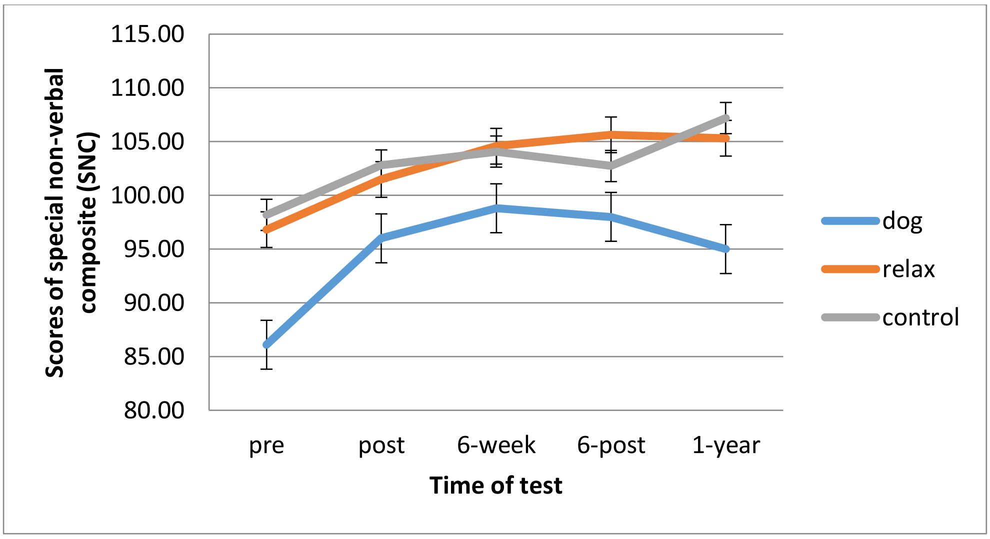

Figure 7. SNC scores: One-to-one interventions, planned comparisons for condition with time (Bonferroni: p = .004)

6.2.1.2 Group sessions: Special Non-Verbal Composite (SNC)

A significant main effect of time was revealed [F (4, 220) = 18.306, p < .001, η_p^2 = .250] for global measures of non-verbal cognition, with time explaining a high degree of variance within the model. Post-hoc paired samples t-test revealed that scores for children in the group sessions increased significantly up to the 6-week test times (see Table 15).

Table 15
SNC, group intervention sessions: planned comparisons for significant main effect of time (Bonferroni: p = .0125)

SNC, paired samples by time	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Pre-post intervention	-3.516	8.469	-3.269	61	.002
Post int. to 6-week	-4.693	7.999	-4.620	61	.000
6-week to 6-month	2.344	7.997	2.289	60	.026
6-month to 1-year	-1.366	9.527	-1.111	59	.271

No main effect of condition [F (2, 55) = 3.080, p = .054, η_p^2 = .101] and no interaction with condition [F (8,220) = 1.313, p = .238, η_p^2 = .046] were revealed for group interventions. Planned comparisons for condition over time showed that children in all groups made significant improvements in scores of SNC; dog (t (17) = -4.953, p < .001), relaxation (t (17)

= -3.677, $p < .002$), control (t (25) = -3.646, $p < .001$). Not all groups made significant improvements between consecutive test times. With children in the dog (t (17) = -4.953, $p < .001$) and relaxation groups (t (16) = -3.470, $p = .003$) showing significant improvements between the post-intervention and 6-week test times (see Figure 8).

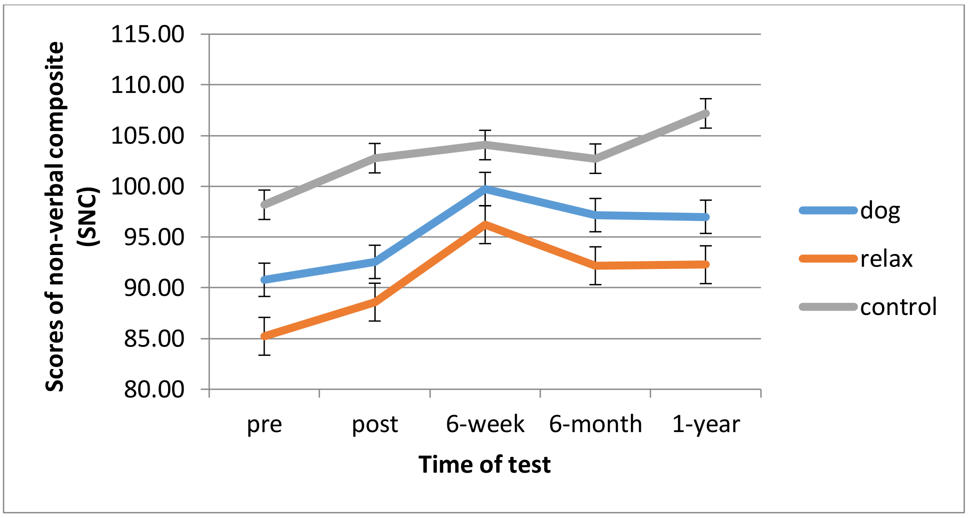

Figure 8. SNC: Group interventions, planned comparisons for condition with time (Bonferroni; $p = .004$)

6.2.1.3 Summary: Special Non-verbal Composite (SNC)

Overall, children's SNC scores were not impacted by gender or dog ownership status. As expected, children's SNC scores showed a significant main effect for time with improvement between the baseline and 1-year test times, and specific improvements observed between the pre- and post-intervention, and 6-week test times (see figure 4). Partial Eta Squared also indicated that time accounted for a high degree of variance within the model. While no significant interaction of time with condition was found, planned comparisons revealed that as predicted, scores for children in the dog and relaxation conditions improved significantly up the 6-week test times, whereas children in control condition show no such improvements at these test times.

Data was then analysed separately depending on whether children took part in one-to-one or group intervention sessions. In line with the overall analysis, a main effect of time was found for both session types. No significant interaction for time with condition was present however, planned comparisons showed differences with children who took part in the one-to-one interventions only showing a significant increase in SNC from baseline to immediately after intervention in the dog condition. Those in the group interventions showed significant improvements in SNC scores in both the dog and relaxation groups between the post-intervention and 6-week test times.

In order to assess the skills which made up the special non-verbal composite (above), further analysis was carried out for Non-verbal Reasoning (NVR) and Spatial ability (SA) separately.

6.2.2 All children: Non-Verbal Reasoning

Children's non-verbal reasoning scores increased over the 1-year study, with the exception of boys without a dog at home in the dog condition, boys with a dog at home in the relaxation condition, and girls with no-dog at home in the control condition who show a slight reduction in scores at the 1-year assessment. Children in the control conditions start with higher baseline scores, apart from the girls who have no dog at home. Again, dog-ownership status was unequal across gender, with one third of boys having a dog at home, compared with equal numbers of girls with and without a dog. The following tables 16-18 show the results by intervention condition.

Table 16
Mean and standard deviation data for children's NVR scores in dog condition, split by gender and dog ownership demographics

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	6	86.333	9.003
		Post-intervention	5	99.200	11.755
		6-week	6	100.333	10.347

		6-month	6	90.833	14.579
		1-year	6	84.500	10.540
	No dog	Pre-intervention	13	87.461	16.686
		Post-intervention	13	88.384	20.430
		6-week	13	92.307	21.807
		6-month	13	93.692	25.888
		1-year	13	92.692	21.053
Female	Dog	Pre-intervention	12	83.416	11.413
		Post-intervention	12	87.666	15.328
		6-week	12	90.750	15.106
		6-month	12	90.250	17.019
		1-year	12	85.666	13.131
	No dog	Pre-intervention	8	90.250	13.242
		Post-intervention	8	93.625	12.569
		6-week	8	93.625	16.970
		6-month	7	96.571	11.028
		1-year	7	101.571	16.659

Table 17
Mean and standard deviation data for children's NVR scores in relaxation condition, split by gender and dog ownership demographics

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	8	94.125	16.881
		Post-intervention	8	95.500	16.300
		6-week	8	103.375	18.298
		6-month	7	98.428	16.949
		1-year	8	93.375	16.526
	No dog	Pre-intervention	10	90.300	19.737
		Post-intervention	9	99.000	21.868
		6-week	10	96.700	17.120
		6-month	10	95.600	19.483
		1-year	10	96.200	20.916
Female	Dog	Pre-intervention	8	93.500	20.248

		Post-intervention	8	93.125	25.870
		6-week	8	100.875	22.138
		6-month	8	93.625	16.535
		1-year	7	95.714	17.679
	No dog	Pre-intervention	12	87.250	14.283
		Post-intervention	12	89.333	13.033
		6-week	12	88.916	15.882
		6-month	10	91.100	13.649
		1-year	11	89.727	17.401

Table 18
Mean and standard deviation data for children's NVR scores in control condition, split by gender and dog ownership demographics

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	4	97.750	12.065
		Post-intervention	4	102.750	13.047
		6-week	4	99.000	12.622
		6-month	4	105.250	19.500
		1-year	4	101.000	13.589
	No dog	Pre-intervention	13	106.846	15.307
		Post-intervention	13	100.923	13.671
		6-week	13	103.307	15.765
		6-month	12	97.916	16.994
		1-year	12	102.538	20.102
Female	Dog	Pre-intervention	4	106.750	23.214
		Post-intervention	4	105.500	15.264
		6-week	4	102.750	8.770
		6-month	4	99.250	5.795
		1-year	4	102.750	1.0904
	No dog	Pre-intervention	7	88.142	8.513
		Post-intervention	7	92.571	13.189
		6-week	7	90.142	6.693
		6-month	7	89.285	8.920

	1-year	6	87.833	9.410

To assess the effect of condition, gender and dog ownership on non-verbal reasoning (NVR), a 5 (Time) x 3 (Condition) x 2 (Gender) x 2 (Dog ownership) analysis of variance was conducted with repeated measures on the factor of time. Data met assumptions of sphericity; Mauchly's test (W (9) = .886, p = .356). A significant main effect of time on children's non-verbal reasoning scores was found [F (4,336) = 5.313, p < .001, η_p^2 = .059] with time explaining a moderate degree of variance within the model. Planned comparisons showed that children's non-verbal reasoning scores only increased significantly immediately after intervention (see Table 19).

Table 19
NVR, planned comparisons for significant main effect of time (Bonferroni: p = .0125)

SNC, paired samples by time	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Pre-post intervention	-3.359	10.26	-3.320	102	.001
Post intervention to 6-week	-1.951	9.23	-2.144	102	.034
6-week to 6-month	1.770	10.79	1.640	99	.104
6-month to 1-year	0.602	9.63	0.619	97	.538

No main effect for condition [F (2, 84) = .850, p = .431, η_p^2 = .020] or interaction of time with condition were found [F (8,336) = 1.209, p = .293, η_p^2 = .028]. Planned comparisons were conducted and also confirmed that scores between consecutive time points across all conditions were not significantly different (see Appendix 11). Comparisons for NVR scores from baseline to the 1-year test time showed a greater effect for the dog condition, although values did not reach significance once adjusted; dog (t (37) = -2.300, p = .027), relaxation (t (36) = -1.871, p = .069), control (t (25) = -1.187, p = .246) (Bonferroni; p = .016). No further significant main effects of gender or dog ownership, or any interactions reached significance (see Figure 9).

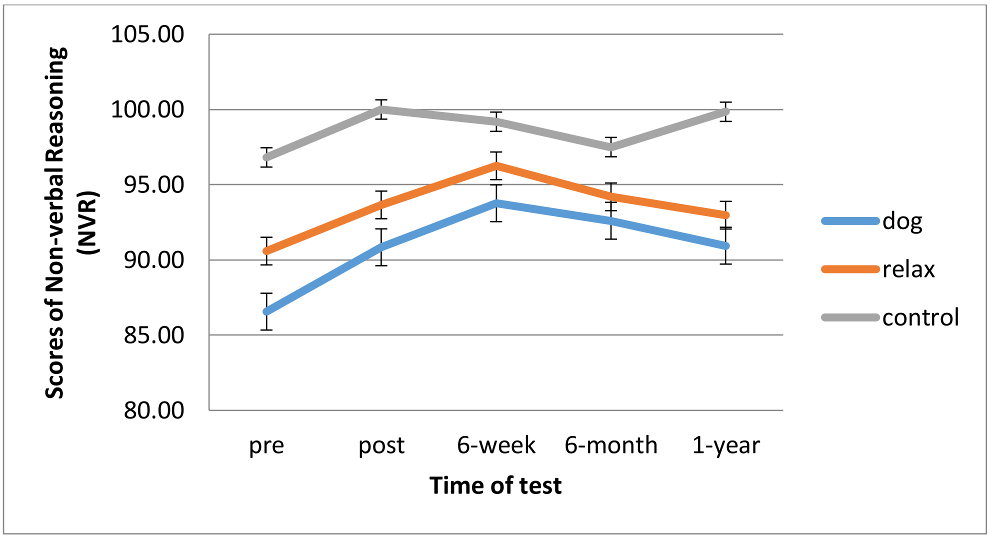

Figure 9. All children, planned comparisons for condition over time on children's scores of non-verbal reasoning (NVR) (Bonferroni: *p* = .004)

In order to investigate the baseline differences in NVR scores between conditions, two further one-way analyses of variance were conducted. A significant difference was revealed [F (2, 104) = 3.624, p = .030, η_p^2 =. 066] at baseline, with the children in the dog condition showing significantly lower scores (M = 86.56) than children in the relaxation (M = 90.58) and control conditions (M = 90.81). However this was no longer present at the post-intervention test time [F (2, 102) = 2.437 p = .093, η_p^2 =. 043] (see Figure 9).

As no effects of gender or dog ownership were found within the NVR data, these are excluded from further analysis to assess the effect of session-type (one-to-one and group) The following results for one-to-one and group sessions are each analysed using 5 (Time) x 3 (Condition) analyses of variance with repeated measures on the factor time. Violation of sphericity was tested and corrections used as appropriate (see Appendix 10).

6.2.2.1 One-to-one sessions: Non-Verbal Reasoning (NVR)

A significant main effect of time was revealed [*F* (4,240) = 4.199, *p* = .003, η_p^2 =.065] for measures of non-verbal reasoning, with time explaining a moderate level of variance within the model. Planned comparisons showed children's scores only increased significantly immediately after intervention (see Table 20).

Table 20
NVR one-to-one sessions: planned comparisons for significant main effect of time

NVR, paired samples by time	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Pre-post intervention	-4.735	9.115	-4.284	67	.000
Post intervention to 6-week	.0294	8.804	.028	67	.978
6-week to 6-month	1.323	11.368	.938	64	.352
6-month to 1-year	.396	9.410	.335	62	.739

No significant main effect of condition [F (2, 60) = 2.361, p = .103, η_p^2 =.073 or interaction of time with condition [F (8,240) = .829, p = .578, η_p^2 =.027] reached significance within the NVR scores. In order to investigate the effect of AAI further, planned comparisons for condition across time were conducted and revealed that only the children in the one-to-one dog intervention showed a significant increase immediately after intervention (t (19) = -4.261, p = .001). Comparisons from baseline to the 1-year tests show that children who took part in dog sessions (t19) = -2.251, p = .036) improved more than those in relaxation (t (18) = -.587, p = .565) and control (t (25) = -1.187, p = .246) (Bonferroni; p = .016) although this failed to reach significance once adjusted. No other consecutive test time for any condition reached significance for those who took part in one-to-one intervention sessions (see Figure 10).

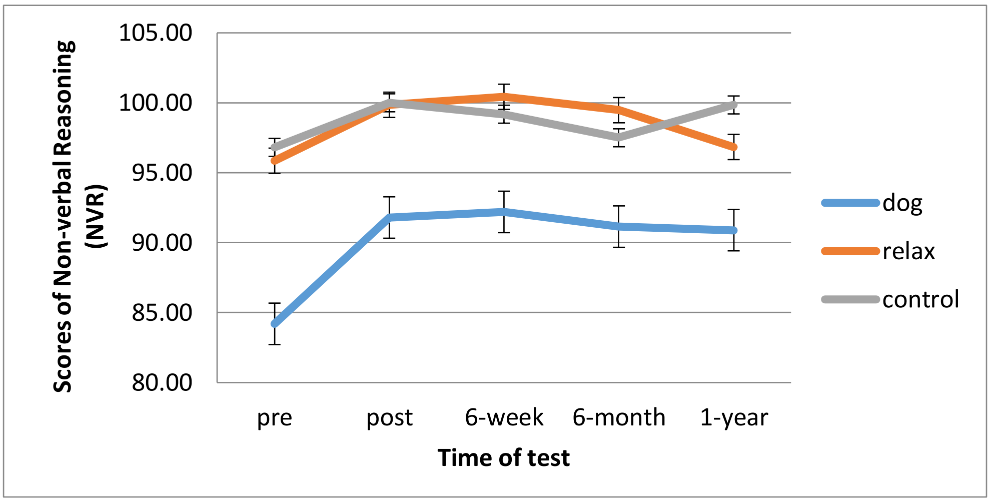

Figure 10. One-to-one interventions, planned comparisons for condition over time on children's scores of non-verbal reasoning (NVR) (Bonferroni; p = .004)

6.2.2.2 Group sessions: Non-Verbal Reasoning (NVR)

Analysis revealed a significant main effect of time [F (4,220) = 4.938, p = .001, η_p^2 =.082] showing that all children's NVR scores changed significantly over time, with time explaining moderate variance within the model. Planned comparisons showed that children in the group interventions demonstrated significantly increased NVR skills between post-intervention and the 6-week test time (see Table 21).

Table 21
NVR group sessions: planned comparisons for significant main effect of time (Bonferroni; p = .0125)

NVR, paired samples by time	*M*	*SD*	*t*	*df*	*Sig (2-tailed)*
Pre-post intervention	-1.774	10.561	-1.323	61	.191
Post intervention to 6-week	-2.919	8.768	-2.621	61	.011
6-week to 6-month	1.754	9.184	1.492	60	.141
6-month to 1-year	.133	9.743	.106	59	.916

No significant main effect of condition [F (2, 55) = 2.327, p = .107, η_p^2 =.078] and no interaction of time with condition were revealed [F (8, 220) = 1.394, p = .200, η_p^2 =.048]. Children in the relaxation interventions showed the most improvement over the one year study with children in the group dog condition showing the least improvement; dog (t (17) = -

.879, p = .392), relaxation (t (17) = -2.577, p = .020), control (t (25) = -1.187, p = .246) (Bonferroni; p = .016). Planned comparisons between consecutive tests showed that all interactions failed to reach significance for children in the group intervention sessions (see Figure 11).

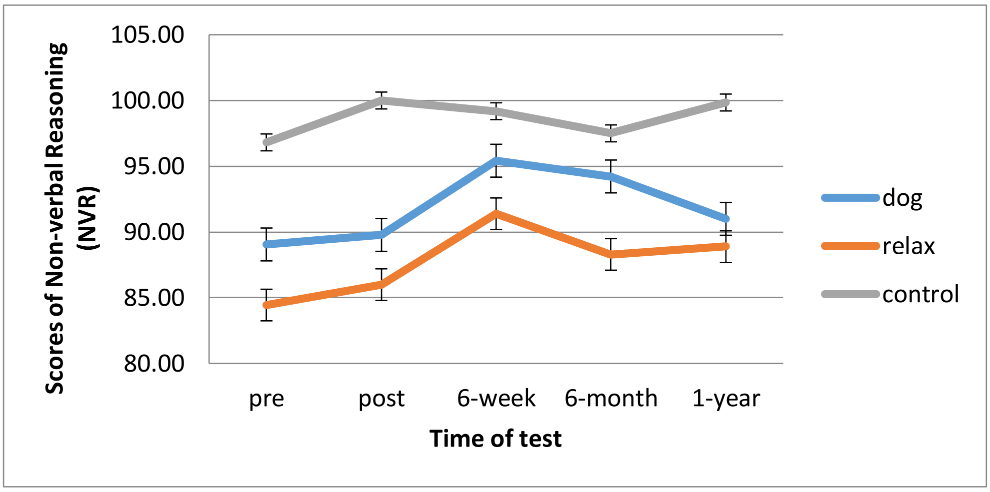

Figure 11. Group interventions, planned comparisons for condition over time on children's scores of non-verbal reasoning (NVR) (Bonferroni: p = .004)

6.2.2.3 Summary: Non-Verbal Reasoning (NVR)

As expected, a significant main effect of time showed that children's scores of non-verbal reasoning (NVR) increased over the one-year test period, with consecutive test times up to post-intervention assessment showing significant overall increases in scores of NVR. Effect sizes demonstrated that time accounted for a moderate degree of variance, not accounted for by other factors within the model.

Unexpectedly, children's scores of non-verbal reasoning (NVR) showed no significant main effect or interaction of condition with time. Equally, no main effects or interactions for gender and dog ownership were present. As the effects of dog-assisted interventions were of interest to the study, planned comparisons were conducted which revealed that NVR scores between consecutive time points across all conditions was not significantly different. Scores from baseline across the length of the one year study showed a greater effect for those children who took part in the dog interventions. Whilst post-hoc analysis revealed that baseline NVR scores were significantly different between conditions before interventions began, this difference was no longer evident after the post-intervention test time, with children in the dog condition showing increased scores by the post-intervention test time.

Data analysis carried out separately for session-type showed a significant main effect of time for both one-to-one and group interventions, however, significant increases in scores of NVR between consecutive test times were demonstrated differently in both. Children who took part in the one-to-one interventions showed significant increases between pre- and post-interventions, whilst those in the group interventions showed a delayed increases between the post-intervention and 6-week test times overall.

Neither one-to-one, nor group interventions showed an interaction of time with intervention condition for children's scores of NVR. Planned comparisons with data split by condition showed that whilst children who took part in the group interventions showed no significant increases in scores between each of the consecutive time points, those who took part in the one-to-one interventions and who were allocated to the dog intervention, showed a significant increase in scores of NVR between the pre- and post- intervention test times.

6.2.3 All children: Spatial ability

Dog-ownership status was unequal across gender, with one third of boys having a dog at home, compared with equal numbers of girls with and without a dog. All mean scores of spatial ability increase from baseline to the 1-year test time, with a peak in scores often observed between the 6-week and 6-month assessments. Data split by dog ownership shows that children with a dog at home have higher mean scores at baseline, than those with no dog at home, except for boys in the relaxation condition who show similar mean scores. The following tables 22-24 show the results by intervention condition.

Table 22
Mean and standard deviation data for children's spatial ability scores in the dog intervention, split by gender and dog ownership demographics

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	6	95.833	18.345
		Post-intervention	5	96.800	20.376
		6-week	6	107.500	14.096
		6-month	6	105.500	13.095
		1-year	6	103.000	15.046
	No dog	Pre-intervention	13	89.307	16.735
		Post-intervention	13	98.538	17.844
		6-week	13	101.538	19.337
		6-month	13	104.000	20.619
		1-year	13	99.076	15.239
Female	Dog	Pre-intervention	12	95.666	14.531
		Post-intervention	12	100.000	21.392
		6-week	12	104.250	20.000
		6-month	12	100.750	17.410
		1-year	12	101.166	16.330
	No dog	Pre-intervention	8	94.375	16.958
		Post-intervention	8	100.875	17.315
		6-week	8	110.000	14.540
		6-month	7	107.142	20.309
		1-year	7	112.142	21.513

Table 23
Mean and standard deviation data for children's spatial ability scores in the relaxation intervention, split by gender and dog ownership demographics

Gender	Dog owner	Time	N	M	SD
Male	Dog	Pre-intervention	8	98.375	18.859
		Post-intervention	8	108.875	10.920
		6-week	8	106.125	10.722

		6-month	7	110.571	17.232
		1-year	8	114.000	11.735
	No dog	Pre-intervention	10	98.200	11.961
		Post-intervention	9	101.666	16.665
		6-week	10	112.100	14.723
		6-month	10	107.100	14.082
		1-year	10	114.400	18.032
Female	Dog	Pre-intervention	8	93.375	22.468
		Post-intervention	8	94.875	19.664
		6-week	8	102.375	20.493
		6-month	8	106.125	21.490
		1-year	7	95.428	14.443
	No dog	Pre-intervention	12	89.333	14.480
		Post-intervention	12	93.416	12.048
		6-week	12	102.250	17.894
		6-month	10	98.900	15.680
		1-year	11	98.818	17.577

Table 24
Mean and standard deviation data for children's spatial ability scores in control condition, split by gender and dog ownership demographics

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	4	105.500	22.752
		Post-intervention	4	100.500	16.782
		6-week	4	109.750	19.137
		6-month	4	107.250	18.839
		1-year	4	109.750	20.886
	No dog	Pre-intervention	13	98.615	13.357
		Post-intervention	13	106.153	12.667
		6-week	13	107.307	10.742
		6-month	12	108.250	14.397
		1-year	12	110.461	17.395
Female	Dog	Pre-intervention	4	103.250	10.242
		Post-intervention	4	114.250	10.045

	6-week	4	114.500	15.673
	6-month	4	111.250	8.616
	1-year	4	119.000	15.143
No dog	Pre-intervention	7	94.571	7.721
	Post-intervention	7	99.428	15.306
	6-week	7	104.000	14.708
	6-month	7	102.428	15.393
	1-year	6	104.666	14.207

To investigate the effect of intervention condition, gender and dog ownership on children's spatial reasoning skills, a 5 (Time) x 3 (Condition) x 2 (Gender) x 2 (Dog ownership) analysis of variance with repeated measures on the factor time was calculated. Data met the assumptions of sphericity as demonstrated through Mauchly's test (W (9) = .887, p = .361). A significant main effect of time was revealed [F (4,336) = 32.358, p < .001, η_p^2 =.278] with the partial eta squared showing that time accounted for a large amount of variance within the model. Planned comparisons revealed that children's spatial ability scores improved significantly between pre and post-interventions (t (102) = -5.070, p < .001) and post-intervention to 6-week test times (t (102) = -5.744, p < .001) (see Table 25).

Table 25
Spatial ability, planned comparisons for significant main effect of time (Bonferroni: p=.0125)

Spatial ability, paired samples by time	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Pre-post intervention	-5.601	11.214	-5.070	102	.000
Post intervention to 6-week	-5.203	9.194	-5.744	102	.000
6-week to 6-month	1.070	11.073	-9.66	99	.336
6-month to 1-year	-.775	11.058	-.693	97	.490

No significant main effect [F (2, 84) = .787, p = .459, η_p^2 =.018] or interaction of condition with time [F (8,336) = .728, p < .667, η_p^2 =.017] was found for children's spatial ability, however planned comparisons revealed that children in the dog condition made significant improvements in spatial ability between the pre-and post- (*t* (37) = -3.499, *p* = .001), and post- to 6-week test times (*t* (37) = -4.507, *p* < .001). Children who took part in the relaxation condition showed a significant increase in scores between the post-intervention and 6-week test times (*t* (37) = -3.861, *p* <.001) (see Figure 12). Overall, children across all conditions showed a significant increase in scores between baseline and the 1-year assessments; dog (*t* (37) = -5.936, *p* <.001), relaxation (*t* (36) = -7.373, *p* <.001), control (*t* (25) = -4.540, *p* <.001) (Bonferroni; *p* =.016). No other comparisons between consecutive test times, for any condition, reached significance once adjusted (see Appendix 11). No effects for gender or dog ownership or any interactions were significant.

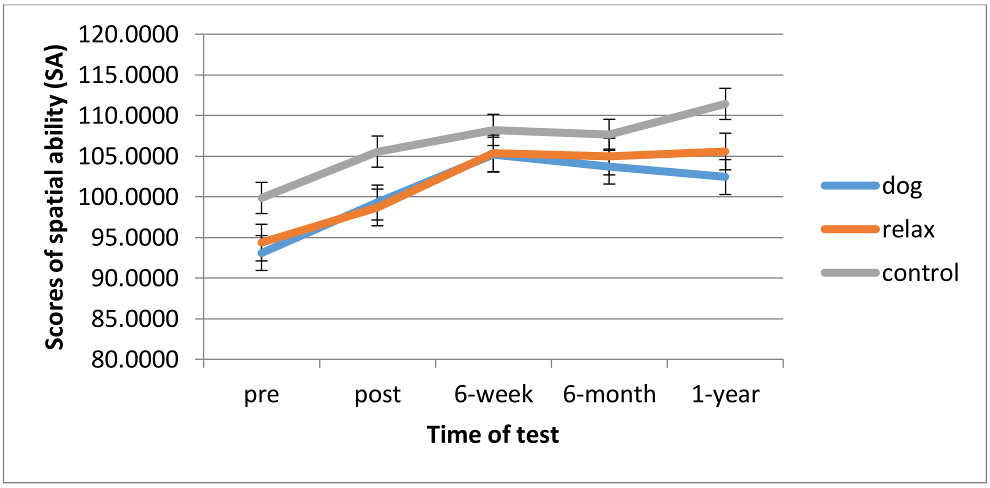

Figure 12. All children, planned comparisons for condition over time on children's scores of spatial ability (SA) (Bonferroni: *p* = .004)

As no effect of gender or dog ownership were found within the spatial ability data, these are excluded from further analysis to assess the effect of session-type (one-to-one and group). Further 5 (Time) x 3 (Condition) analyses of variance with repeated measures on the factor of time were carried out for spatial ability. Sphericity of data was assessed and corrections used where needed (see Appendix 10).

6.2.3.1 One-to-one sessions: Spatial ability (SA)

Again, a significant effect of time was revealed [F (4, 240) = 27.567, p < .001, η_p^2 = .315] showing that overall children's spatial ability scores in the one-to-one sessions significantly increased over time. Partial Eta Squared shows that a large proportion of variance within the model was accounted for by time. Planned comparisons show children's spatial ability scores improved significantly between both the pre-to post-intervention (t (67) = -4.575, p < .001), and post-intervention to 6-week test times (t (67) = -3.784, p < .001) (see Table 26).

Table 26
Spatial ability one-to-one sessions: planned comparisons for significant main effect of time (Bonferroni: p = .0125)

Time of test	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Pre-post intervention	-6.382	11.503	-4.575	67	.000
Post intervention to 6-week	-4.044	8.813	-3.784	67	.000
6-week to 6-month	-.338	11.233	-.243	64	.809
6-month to 1-year	-.746	12.487	-.474	62	.637

No significant main effect for condition was revealed for children taking part in one-to-one sessions [F (2, 60) = 1.192, p = .311, η_p^2 = .038], but a significant interaction of time and condition was present within the spatial ability scores for children taking part in one-to-one conditions [F (8,240) = 2.128, p = .034, η_p^2 = .066]. All conditions showed improved spatial ability scores; dog (t (19) = -3.571, p = .002), relax (t (18) = -7.565, p < .001), control (t (25) = -4.540, p < .001) between baseline and 1-year tests. Planned comparisons between consecutive tests indicated that only children in the dog condition showed a significant increase in SA scores between the pre- and post-intervention tests (t (19) = -3.897, p = .001), all other consecutive comparisons across all conditions failed to reach significance (see Table 27 and Figure 13).

Table 27

Spatial ability one-to-one sessions: planned comparisons for significant interaction of condition with time (Bonferroni: p = .004)

Condition	Time of test	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Dog	Pre-post	-9.950	11.417	-3.897	19	.001
	Post - 6-week	-4.450	7.493	-2.656	19	.016
	6-week - 6-month	-.250	11.054	-.086	19	.933
	6-month- 1-year	5.250	12.997	1.806	19	.087
Relaxation	Pre-post	-3.857	12.374	-1.428	20	.169
	Post - 6-week	-5.428	9.805	-2.537	20	.020
	6-week - 6-month	-1.631	12.464	-.571	18	.575
	6-month- 1-year	-4.111	11.076	-1.575	17	.134
Control	Pre-post	-5.703	10.607	-2.794	26	.010
	Post - 6-week	-2.666	9.029	-1.535	26	.137
	6-week - 6-month	.538	8.922	.308	25	.761
	6-month- 1-year	-3.120	11.741	-1.329	24	.196

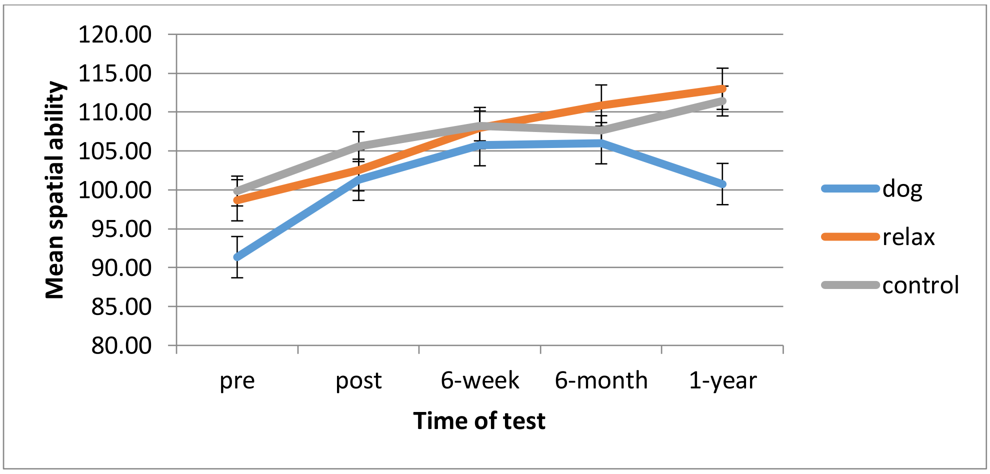

Figure 13. Spatial ability: one-to-one sessions, significant interaction of time and condition

6.2.3.2 Group sessions: Spatial ability (SA)

In line with previous assessments, a highly significant effect of time was revealed [F (4,220) = 22.277, p < .001, η_p^2 =.288] showing that children's learning improved and their spatial scores significantly increased over time. Effect size showed that a large amount of variance within the model could be attributed to the factor of time. Planned comparisons for the main effect of time revealed that spatial scores for children in the group intervention sessions increased significantly between the pre and post-intervention, and again between the post-intervention and 6-week tests times (see Table 28).

Table 28
Spatial ability group sessions: planned comparisons for significant main effect of time (Bonferroni: p = .0125)

Time of test	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Pre-post intervention	-4.790	10.563	-3.571	61	.001
Post intervention to 6-week	-5.370	9.597	-4.407	61	.000
6-week to 6-month	2.344	9.860	1.857	60	.068
6-month to 1-year	-1.783	9.775	-1.413	59	.163

Concerning effects of AAI, no significant effect of condition [F (2, 55) = 3.065, p = .055, η_p^2 =.100] or interaction between time and condition were revealed [F (8,220) = 1.429, p = .185, η_p^2 =.049]. All children made improvements in all conditions between the baseline and 1-year test time; dog (t (17) = -6.149, p < .001), relax (t (17) = -3.608, p = .002), control (t (25) = -4.450, p < .001). Planned comparisons for the effect of AAI on spatial ability revealed that only children in the dog group interventions made significant improvement in spatial ability between the post-intervention and 6-week test (t (17) = -3.713, p = .002). No other consecutive comparisons across conditions reached significance (see Figure 14).

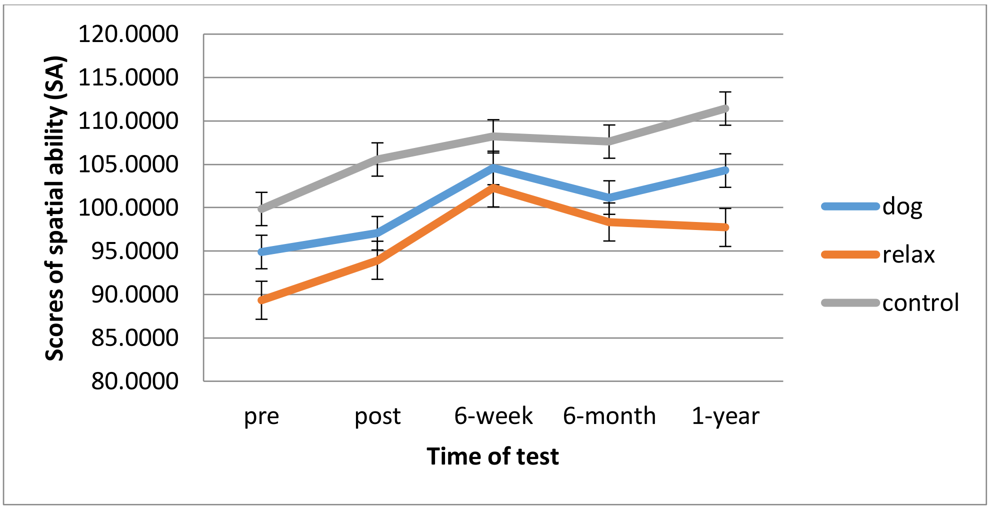

Figure 14. Spatial ability: significant interaction of time and condition for children participating in group intervention sessions

6.2.3.3 Summary: Spatial ability (SA)

As expected, children's spatial ability scores increased over the 1-year study, with planned comparisons revealing significantly increased scores to the 6-week test time. Effect sizes indicated that time represented a large proportion of the variance within the model. No significant main effect of condition or interaction of time with condition, were present within the data, but planned comparisons revealed that children across all conditions had a significant increase in scores across the length of the study, with specific and significant increases between the pre- and post- intervention times if they took part in the dog condition and again between the post- intervention and 6-week tests if they were in the relaxation interventions.

Analysis looking at session-type revealed a significant interaction of condition with time for children who took part in one-to-one sessions, with those in the dog condition having significantly improved spatial ability scores immediately after intervention. Whilst analysis for those in the group sessions failed to reach significance for an interaction of condition with time, planned comparisons showed that those in group sessions with a dog made significant improvements between the post-intervention and 6-week test times. No further main effects or interactions for gender and dog ownership were found in relation to spatial ability scores.

6.3 Discussion: British Ability Scales (BAS)

The hypothesis that general learning and maturation effects would be expected was confirmed, with all analyses for each of the BAS cognitive assessments, including the SNC, NVR and Spatial task demonstrating children's increased learning over time. All children's scores on the cognitive tasks improved significantly over the course of the one year study. The further hypotheses that gender and dog ownership would not affect outcomes was also confirmed as no differences existed overall between boys' and girls' in terms of learning or between children's learning based on whether they were dog owners or not.

Overall, children's cognitive scores improved significantly between the baseline and one year test times, even though increases were not always seen between consecutive test times. This increase in children's cognitive tasks would be expected, given that children's cognitive capacity is developing rapidly as a result of their age and formal education. It is interesting that children's scores for cognition deteriorate somewhat after the 6-week follow up point (although not always significantly). Three possible reasons could be put forward to account for this result. Firstly repeated use of the BAS tool kit in close time proximity may have resulted in memory effects which artificially support the early test results up to a 6-week time point but disappear after a longer break of 6-months. Secondly, children's cognitive scores may fluctuate as the school term progresses, as learning and development do not always represent a linear process (Ayoub & Fischer, 2006; Reilly, 2000). These results may therefore show a natural slowing of cognitive development. However, this scenario seems unlikely given that all children were tested over the course of a full academic year and commencement of the study was not at the start of the academic year in September for all schools. Therefore all cohorts of children would have started with different levels of experience of the taught curriculum and will not be at the same time point in the school term when completing the assessments. Thirdly, the BAS is a standardised test which means that children's ability is put into the context of their peers and they are compared with others of the same age. However, within any class of children there may be a 12-month age difference between the youngest and oldest child, and their test score will be based on their age when the assessment was carried out. If the child then has a birthday between any consecutive assessments, their standardised score will tip into the next age bracket, which may mean that a higher raw score overall is reduced in order to accommodate the age of the standardised score. This may therefore have had an effect on analysis when all children's scores were combined.

With regard to the effects of AAI, children showed a significant increase in scores of SNC and Spatial ability in dog, relaxation and control conditions across the length of the study from baseline to the 1-year time point demonstrating the improvement in scores over time. When assessed in terms of consecutive tests over the course of the study, those children who took part in the dog and relaxation conditions had significantly increased SNC scores up to the 6-week assessment, but not those in the control condition. For consecutive scores of spatial ability, only those in the dog condition made increases between the pre- and post, and post- 6-week sessions, while those in the relaxation condition showed increases later between the post-intervention and 6-week test time. This was not the case for children's scores of NVR which made no significant increases based on condition type which the children took part in, either across the length of the study, or when compared over consecutive test times overall. When data was assessed based on session type, those in the dog condition did show a significant improvement in scores between the baseline and post-intervention test times (see discussion below). Whilst these improvements across conditions are interesting, they should be viewed with caution due to a lack of significant interactions between time and condition.

To investigate whether effects differed depending on whether sessions were carried out individually or in a small group further analysis was carried out. Interestingly, children's NVR scores in the one-to-one sessions with a dog showed a significant improvement between the pre- and post-intervention tests, while the relaxation and control group did not improve. All planned comparisons returned the same findings for the SNC, NVR and SA one-to-one sessions with children demonstrating significant increases in scores between the pre- and post-intervention test times after taking part in the dog-assisted interventions. The relaxation and control conditions did not show such an effect, demonstrating the beneficial effects of AAI. Group sessions did not produce such consistent results with a delay in improvements between the post-intervention and 6-week tests for SNC scores after taking part in either the dog or relaxation interventions, and for spatial scores in the dog condition. In contrast to the one-to-one sessions, children who took part in group interventions showed no significant increases in consecutive NVR scores regardless of the condition which they took part in.

The effect of the dog interventions was observed immediately after interventions, and demonstrated the immediate positive effect of the dog intervention on children's cognitive scores. For spatial ability in the group interventions this effect was also present up to the 6-week assessment. A lack of further significant improvements over time leads to the conclusion that dog interventions did not appear to show longevity past the post-intervention test time for the majority of measures, with a few to the 6-week assessment. This result confirmed the hypothesis that dog intervention would show significant improvements in learning, and also that immediate improvements would be stronger than longitudinal improvements. Whilst longitudinal benefits of AAI cannot be asserted, this result does show promise as interventions were carried out twice a week, over four weeks, and the cognitive assessments were carried out in the following week without the presence of a dog in the room. These immediate effects are in line with previous research measuring cognitive type tasks when the dog was present in the room during testing (see Gee et al., 2010a, Gee et al., 2010b, Gee et al., 2012a, Gee et al., 2010b). As there are no comparable studies into the effects of AAI on children's cognition over time (Brelsford et al., 2017) the result of this research pioneers the investigation into longevity.

Of interest is the distinction between the effects of AAI in relation to the improvements seen in SNC and spatial ability scores, compared to those of NVR which did not show significant improvements in performance across the length of the study. The specific abilities required to complete each task efficiently and how these are processed, allow an insight into why the tasks were differentially affected by AAI within this study. The NVR tasks within the British Ability Scales test battery are based on inductive reasoning which includes the ability to detect and apply relationships. Inductive reasoning is goal-oriented and represents a higher order cognitive process which requires purposeful effort (Perrett, 2015; Moshman, 2004). These reasoning abilities are also generally slow to develop in children (Molnar, Greiff & Csapo, 2013) and whilst it can be improved through specific interventions (Li et al., 2004; Klauer, Willmes & Phye, 2002) it is not explicitly tutored within the classroom (de Koning, Hamers, Sijtsma & Vermeer, 2002). Distinctions can therefore be drawn in contrast to the spatial ability tasks, which are made up of short-term memory and spatial visualisation items. These tasks involve working memory (WM) which according to Baddeley & Hitchs' (1974) model incorporates integrated systems of the central executive, phonological loop and visual-spatial sketchpad. These integrated systems represent a flexible cognitive process which can be affected by variety of individual factors, in addition to wider influences such as learning, emotion and stress (Blasiman & Was, 2018). Previous research has cited the positive effects of AAI on memory during cognitive tasks

(Gee et al., 2012a; Hediger & Turner, 2014). Positive emotions can have a beneficial effect on spatial working memory (Storbeck & Maswood, 2016) and affective states can also influence working memory as emotion and cognition become integrated during task performance (Gray, Braver & Raichle, 2002). It could therefore be argued that emotional factors involved during the AAI interventions may have impacted on the spatial ability tasks to produce results beyond those found in the NVR scores. In addition, the slow maturational development of skills underlying the NVR tasks may not have allowed measurable change over the one-year time frame of the study.

As with other topics within the study, little research has been conducted into the effects of pet ownership on educational attainment, with those that have been conducted highlighting the benefits of increased biological and anatomical knowledge for children with pets at home (Geerdts, Van de Walle & LoBue, 2015; Prokop, Prokop & Tunnicliffe, 2008) rather than impact on specific cognitive abilities or wider attainment (see Purewal et al., 2017 for wider critique). This study is therefore unique in its design to combine such measures within a longitudinal RCT and can conclude that dog ownership overall was not seen to influence outcomes of specific cognitive abilities of children measured through the BAS. Equally, those without a pet at home did not appear to benefit more from the dog interventions, as no significant interactions of condition with pet ownership were present within the BAS data.

Children’s scores from the BAS were not affected by children’s gender either. Equally, no interactions of gender with AAI were present which demonstrated that children’s cognitive improvement was not differentially affected by gender in either the dog or relaxation interventions.

Many of the neurological processes involved in the BAS tasks also form part of, and utilise, the integrated neurophysiological systems involved in executive functioning. One process integral to executive function is inhibitory control; the ability to attend to and process relevant information, whilst suppressing irrelevant information. This ability is crucial for efficient cognitive development and wider daily life skills. In light of the differences found between the BAS tasks, the effect of AAI on executive functioning, and inhibitory control specifically, was assessed next using the Fruit Stroop task.

6.4 Results: Effects of AAI on Executive Function measures with the Fruit Stroop

To assess the effects of AAI on executive function, a speed-reaction time Fruit Stroop task was carried out. This task tested inhibitory functioning which is integral to executive function and the cognitive abilities of children. Testing such functions may potentially help narrow down which particular pathways are affected during animal-assisted interventions. Results will be calculated first for all children, then per session type (individual and group interventions).

Inspection of the pre-intervention raw data scores using the Shapiro-Wilk test revealed that data met the assumptions of normality for neutral colour shapes (W = .982 p = .174) and blank fruit (W= .980, p = .112), but incongruent colour fruit did not meet normality (W= .971, p = .022). Visual inspection of the data showed only slight violations from normality with skewness of .629 (SE = .236) and kurtosis of .733 (SE = .467); parametric tests are therefore applied for analysis of the Stroop data.

An initial one-way analysis of variance was conducted on baseline scores of Stroop data to assess whether data collection varied significantly between schools. No significant effect of school was returned for incongruency [F (4, 104) = .440, p = .780, η_p^2 =.017], colour processing [F (4, 104) = 1.000, p = .411, η_p^2 =.038] or speed of processing [F (4, 104) = 2.168, p = .078, η_p^2 =.080]. The data was therefore collapsed over schools for further analysis.

6.4.1 All children: Fruit Stoop

Investigation into the effects of AAI on the Fruit Stroop task was carried out in four separate ways. Firstly, the effect of AAI on children's error rates was investigated. Secondly, the effect of AAI on children's interference scores was carried out based on congruency (congruent vs incongruent fruit). Thirdly, assessment of the task was conducted based on interference during colour processing (neutral shape vs incongruent fruit). Lastly, the effect of AAI on speed of processing (SOP) was assessed (see methods subsection 5.2.2.2 for formula used to calculate interference scores). For each method, the effects of AAI on children's processing of the Fruit Stroop was carried out for all children, then data was split based on session-type (whether children took part in one-to-one or group interventions).

6.4.1.1 Analysis of raw data scores: Error rates

Children's scores were totalled for the number completed, number of correct responses and error rates for each of the three conditions. Items were counted as correct if a mistake had been crossed out and re-marked correctly by the child within the 30 seconds timeframe. Children made very few errors in completing the three different tasks. Of the 33,246 completed scores, only 197 errors were made in total which amounts to 0.59% error overall. As would be expected of the Stroop task, the congruent blank fruit condition elicited the least error (0.2%), followed by the neutral shape condition (0.39%) and lastly the incongruent fruit condition with the most error (1.34%) reflecting a measure of processing difficulty (see Table 29).

Table 29

Error made within each task and the percentage these represent from the overall scores.

Time point	Stroop task	Total items completed	Total no. of errors	Total % error rate
Baseline	Neutral colour (NC)	2143	20	.93
	Congruent blank fruit (CBF)	2043	5	.24
	Incongruent colour fruit (ICF)	1669	62	3.71
Post	Neutral colour (NC)	2368	13	.55

	Congruent blank fruit (CBF)	2214	10	.45
	Incongruent colour fruit (ICF)	1802	24	1.33
6-weeks	Neutral colour (NC)	2575	5	.19
	Congruent blank fruit (CBF)	2368	4	.17
	Incongruent colour fruit (ICF)	1925	19	.99
6-months	Neutral colour (NC)	2534	4	.16
	Congruent blank fruit (CBF)	2364	3	.13
	Incongruent colour fruit (ICF)	1916	11	.57
1-year	Neutral colour (NC)	2697	6	.22
	Congruent blank fruit (CBF)	2562	1	.04
	Incongruent colour fruit (ICF)	2066	10	.48
Totals				
5 time-points	Neutral colour (NC)	12317	48	.39
	Congruent blank fruit (CBF)	11551	23	.20
	Incongruent colour fruit (ICF)	9378	126	1.34
Total	All tasks	33246	197	.59

Paired samples t-tests confirm that error rates were not significantly different across the three tasks and errors were not affected by the intervention condition (Table 30).

Table 30
Paired sample t-tests for error rates of task type and intervention condition

Condition	Paired samples	*M*	*SD*	*t*	*df*	*Sig (2-tailed)*
Dog	Shape – blank fruit	.289	3.328	.536	37	.595
	Shape – colour fruit	-1.815	7.126	-1.570	37	.125
	Blank – colour fruit	-2.105	7.917	-1.639	37	.110
Relaxation	Shape – blank fruit	.235	1.016	1.349	33	.186
	Shape – colour fruit	.235	4.811	.285	33	.777
	Blank – colour fruit	.000	4.817	.000	33	1.000
Control	Shape – blank fruit	.259	1.558	.864	26	.395
	Shape – colour fruit	-6.370	29.690	-1.115	26	.275
	Blank – colour fruit	-6.629	29.667	-1.161	26	.256

6.4.2 All children: Interference scores, congruent vs incongruent fruit

The Fruit Stroop scores were first analysed to assess the effect of AAI on interference scores based on congruency. Interference scores in this section represent differences in processing between congruent and incongruent stimuli, whereby greater values indicate interference and lower scores reflect better performance on the task (see subsection 5.2.2.2 for formula used). Scores were assessed first for all children, and then again depending on session-type (whether children took part in one-to-one or group intervention sessions).

The following tables 31-33 show the results by intervention condition. Children's mean interference scores show fluctuations over the one-year test period. Girls who took part in the dog condition show a decrease in scores overall, whereas boys show a decrease if they have no dog at home and an increase if they have a pet dog. Boys who took part in the relaxation condition show similar scores at the one-year time point as at the pre-intervention test time, whilst girls show a decrease if they are a dog owner and an increase overall if they have no dog at home. Mean interference scores for those who took in the control condition showed that children with a dog had a decrease in scores over the one-year study, whilst those with no dog showed an increase in interference scores. Two thirds of boys who took part in the dog condition had no dog at home and one third had a pet dog. This pattern was reversed for girls in the dog condition with two thirds having a pet dog, and one third not. Roughly equally numbers of boys and girls in the relaxation condition reported having/ not having a pet dog at home. Whilst three times as many boys in the control condition reported no pet dog, and girls in the control condition reported having a dog were twice as many as those who did not (see Tables 31-33).

Table 31
Fruit Stroop task: Mean and standard deviation data for children's interference scores in the in the dog intervention when calculated for congruent versus incongruent fruit, gender and dog ownership

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	6	22.337	41.663
		Post-intervention	6	22.777	40.175

		6-week	6	19.876	16.837
		6-month	6	26.185	21.080
		1-year	6	27.100	17.236
	No dog	Pre-intervention	13	34.316	24.186
		Post-intervention	13	9.669	27.022
		6-week	13	24.489	17.232
		6-month	13	24.046	15.387
		1-year	13	23.900	12.593
Female	Dog	Pre-intervention	12	18.004	13.929
		Post-intervention	12	18.695	10.012
		6-week	12	19.034	16.817
		6-month	12	14.847	18.774
		1-year	12	14.577	7.543
	No dog	Pre-intervention	8	30.130	11.881
		Post-intervention	8	18.007	16.937
		6-week	8	21.139	7.401
		6-month	7	12.256	24.529
		1-year	7	18.270	26.089

Table 32

Fruit Stroop task: Mean and standard deviation data for children's interference scores in the in the relaxation-intervention when calculated for congruent versus incongruent stimuli, gender and dog ownership

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	8	19.519	8.724
		Post-intervention	8	21.989	19.125
		6-week	8	24.507	10.274
		6-month	7	13.955	10.189
		1-year	8	19.983	11.224
	No dog	Pre-intervention	10	16.277	13.383
		Post-intervention	10	11.147	30.501
		6-week	10	14.584	14.723
		6-month	10	17.114	14.522
		1-year	10	16.077	13.827

Female	Dog	Pre-intervention	8	20.711	9.446
		Post-intervention	8	15.777	20.944
		6-week	8	15.509	21.444
		6-month	8	11.689	20.350
		1-year	7	15.758	9.638
	No dog	Pre-intervention	12	13.440	20.556
		Post-intervention	12	19.453	12.505
		6-week	12	15.651	6.427
		6-month	10	29.931	2.617
		1-year	11	22.510	12.553

Table 33

Fruit Stroop task: Mean and standard deviation data for children's interference scores in the in the control-condition when calculated for congruent versus incongruent stimuli, gender and dog ownership

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	4	25.664	20.700
		Post-intervention	4	14.533	12.266
		6-week	4	25.909	12.153
		6-month	4	16.335	16.805
		1-year	4	16.261	3.722
	No dog	Pre-intervention	13	14.561	17.806
		Post-intervention	13	25.081	17.123
		6-week	13	11.255	16.149
		6-month	13	13.824	14.682
		1-year	13	20.780	17.436
Female	Dog	Pre-intervention	4	16.360	15.690
		Post-intervention	4	22.942	8.315
		6-week	4	15.158	23.157
		6-month	4	14.606	12.878
		1-year	4	14.684	5.415
	No dog	Pre-intervention	7	7.211	24.588
		Post-intervention	7	19.479	20.825
		6-week	7	22.169	7.151

6-month	7	24.304	9.457
1-year	6	21.067	6.209

A 5 x (Time) x 3 (Condition) x 2 (Gender) x 2 (Dog ownership) analysis of variance was calculated to assess differences in interference scores over time, and whether interference was affected by intervention condition or gender or dog ownership. Mauchly's tests reveals that data violates the assumptions of sphericity (χ^2 (9) = 22.112, *p* = .009) therefore degrees of freedom are corrected using Huynh-Feldt estimates of sphericity. No significant main effects or interactions were found for interference scores based on congruent versus incongruent stimuli for condition, gender and dog ownership. As no effect of gender or dog ownership were found, data was collapsed over these factors for further analysis of one-to-one and group interventions. For each analysis, a 5 x (time of test) x 3 (condition) analysis of variance with repeated measures on the factor of time was carried out to assess differences in interference scores; violation of sphericity was tested and corrections applied as appropriate (see Appendix 10).

6.4.2.1 One-to-one sessions: Interference scores, congruent vs incongruent fruit

While no main effects were significant, a significant interaction of time with condition was revealed [F (4, 244) = 2.408, p = .016, η_p^2 =.073]. Planned comparisons for scores from baseline to the 1-year tests showed that none of the conditions had a significant effect on scores across the length of the study (dog (t (19) = 1.734, p = .099); relaxation (t (19) = .949, p = .355); control (t (24) = -.351, p = .729) (Bonferroni; p = .016)). To investigate the interaction of condition over consecutive test times, planned comparisons were conducted which revealed no significant differences (see Appendix 12). Children in the dog condition show more varied performance across time with the interaction created by those in the dog condition showing a reduction in interference immediately after intervention, which just failed to reach significance (t (19) = 3.281, p = .004), followed by a further increase and decrease to the 6-month test time (see Figure 15).

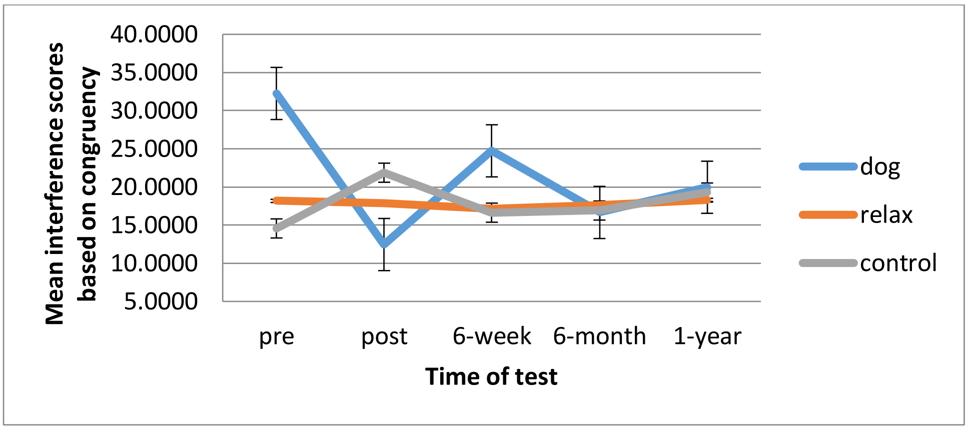

Figure 15. Interference based on congruency: interaction of time and condition (Bonferroni; p = .004)

As the pre-intervention interference scores for children in the dog condition started higher than children's scores in the relaxation and control conditions, two further post-hoc one-way analyses of variance were carried out. Children's interference scores based on congruency were significantly different before intervention, with children in the dog group showing significantly higher levels of interference (pre M = 32.25) [F (2, 67) = 5.905, p = .004, η_p^2 = .154], than those in the relaxation (pre M = 18.17) and control conditions (pre M = 14.56). However, this difference between conditions was no longer present at the post-intervention test time [F (2, 67) = 1.706, p = .190, η_p^2 = .050], with children in the dog condition showing lower post-intervention scores (M = 12.45), than those in the relaxation (post M = 17.91) and control conditions (post M = 21.86).

6.4.2.2 Group sessions: Interference scores, congruent vs incongruent fruit

No significant main effects or interaction for condition were found for scores of interference when children took part in group intervention sessions, planned comparisons showed no differences for intervention condition either (see Appendix 12).

6.4.2.3 Summary: Effects of AAI on Fruit Stroop, interference scores, congruent vs incongruent fruit

Children in the dog condition displayed a significant reduction in interference between the pre- and post-intervention assessments compared to children in other conditions. These differences were present in one-to-one interventions, but not in group-interventions. The effects of the AAI were not lasting beyond the post intervention period for those in the dog condition. Further analysis also revealed that children in the dog condition showed significantly higher interference before intervention compared to children in the other groups. Whilst this significant reduction resulted in no difference between conditions at the post-intervention test time, those in the dog condition did show lower scores overall immediately after intervention. Overall, the pattern of results indicated that children did not show practice effects for the Fruit Stroop task as there is no overall improvement over time.

6.4.3 All children; Interference scores for colour processing- neutral shape vs incongruent fruit

Scores for the Fruit Stroop were next analysed to assess the effect of AAI on interference scores based on colour processing and congruency. Interference scores in this section represent differences in processing between neutral shape and incongruent stimuli, whereby greater values indicate interference and lower scores reflect better performance on the task (see Chapter 5 for formula used). Scores were assessed first for all children, and then again depending on session-type (whether children took part in one-to-one or group intervention sessions).

The following tables 34 – 36 show mean scores by intervention condition and show that children who took part in the dog condition had a decrease in interference scores based on colour processing over the one-year study. Boys in the relaxation condition with a dog at home show an increase in interference whilst those boys with no dog at home showed no change. All girls in the relaxation condition showed a reduction in interference scores by the end of the year. Boys in the control condition showed a decrease in scores if they had a dog at home, whilst those with no dog had similar scores at the one-year test time. This pattern was the opposite for girls in the control condition with those who had a dog showing no increase at the one-year time, and those with no dog at home having increased interference scores by the end of the study (see Tables 34 – 36).

Table 34
Fruit Stroop: Mean and standard deviation data for children's interference scores in dog intervention when calculated for neutral colour versus incongruent stimuli, split by gender and dog ownership.

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	6	34.415	32.972
		Post-intervention	6	32.203	33.568
		6-week	6	23.331	13.265
		6-month	6	25.870	21.472
		1-year	6	31.965	12.826
	No dog	Pre-intervention	13	36.158	21.172
		Post-intervention	13	23.759	18.721
		6-week	13	33.470	12.719
		6-month	13	31.669	15.877
		1-year	13	33.421	13.379
Female	Dog	Pre-intervention	12	20.110	11.740
		Post-intervention	12	23.215	9.007
		6-week	12	22.258	16.337
		6-month	12	16.630	16.492
		1-year	12	14.938	11.793
	No dog	Pre-intervention	8	30.848	13.483
		Post-intervention	8	25.196	13.885
		6-week	8	22.068	18.618
		6-month	7	18.871	18.525
		1-year	7	22.418	11.462

Table 35
Fruit Stroop: Mean and standard deviation data for children's interference scores in relaxation-intervention when calculated for neutral colour versus incongruent stimuli, split by gender and dog ownership.

Gender	Dog owner	Time	N	M	SD
Male	Dog	Pre-intervention	8	16.394	14.022
		Post-intervention	8	25.556	16.874
		6-week	8	32.071	11.733
		6-month	7	22.897	11.398
		1-year	7	27.952	11.173
	No dog	Pre-intervention	10	20.014	13.639
		Post-intervention	10	17.315	28.697
		6-week	10	23.308	15.588
		6-month	10	22.733	9.160
		1-year	10	20.466	14.927
Female	Dog	Pre-intervention	8	26.298	10.888
		Post-intervention	8	24.541	12.408
		6-week	8	23.958	17.543
		6-month	8	23.055	14.227
		1-year	7	15.315	10.186
	No dog	Pre-intervention	12	26.163	12.939
		Post-intervention	12	16.155	15.391
		6-week	12	23.585	11.846
		6-month	10	28.210	11.859
		1-year	11	22.081	20.250

Table 36
Fruit Stroop: Mean and standard deviation data for children's interference scores in control-condition when calculated for neutral colour versus incongruent stimuli, split by gender and dog ownership.

Gender	Dog owner	Time	N	M	SD
Male	Dog	Pre-intervention	4	28.863	18.004
		Post-intervention	4	22.252	12.106
		6-week	4	36.057	16.152
		6-month	4	25.954	7.451
		1-year	4	21.011	9.333

	No dog	Pre-intervention	13	14.327	22.965
		Post-intervention	13	30.624	14.267
		6-week	13	23.144	9.913
		6-month	13	23.478	16.071
		1-year	13	27.074	16.312
Female	Dog	Pre-intervention	4	19.583	4.391
		Post-intervention	4	23.892	3.783
		6-week	4	26.128	13.618
		6-month	4	17.928	10.479
		1-year	4	19.489	14.221
	No dog	Pre-intervention	7	11.682	83.300
		Post-intervention	7	22.558	15.467
		6-week	7	19.793	14.345
		6-month	7	28.090	9.886
		1-year	6	27.654	8.590

A 5 (Time) x 3 (Condition) x 2 (Gender) x 2 (Dog ownership) analysis of variance was carried out to assess differences in interference scores based on processing of the neutral colour and incongruent fruit task, possible interactions of condition and gender are also assessed. Data violated the assumptions of sphericity as demonstrated through Mauchly's test (X^2 (9) = 286.924, p <.001) therefore degrees of freedom are corrected using Greenhouse-Geisser estimates of sphericity. No significant main effects or interactions were revealed for interference based on colour processing for condition, gender or dog ownership (See Appendix 12).

As no effects of gender or dog ownership were found, these are excluded from further analysis to assess the effect of AAI on interference scores for the neutral colour and incongruent fruit task based on session-type (one-to-one and group interventions). The following results are analysed using 5 (Time) x 3 (Condition) analyses of variance with repeated measures on the factor of time. Violation of sphericity was tested and corrections used as appropriate (see Appendix 10).

6.4.3.1 One-to-one sessions: Interference scores for colour processing- neutral shape vs incongruent fruit

No significant main effect for time, condition, or interactions with these factors was significant.

6.4.3.2 Group sessions: Interference scores for colour processing- neutral shape vs incongruent fruit

No significant main effect for time, condition, or interactions with these factors was significant.

6.4.3.3 Summary: Fruit Stroop, interference scores - colour processing neutral shape v incongruent fruit.

No significant main effects or interactions were present overall for colour -processing of the Fruit Stroop. This was also the case once data was split for session-type, with no significant main effects or interactions present in either the one-to-one or group intervention sessions. No other interactions for gender or dog ownership were present for overall colour processing within the Fruit Stroop task.

6.4.4 All children: Speed of processing (SOP)

The effect of AAI on scores from the Fruit Stroop was also assessed in relation to children's speed of processing (SOP). Higher scores represent more correct items processed per second (s) which indicates better performance on the task (see subsection 5.2.2.2 for formula used). Scores were assessed first for all children, and then again depending on whether children took part in one-to-one or group intervention sessions.

A 5 (Time) x 3 (Condition) x 2 (Gender) x 2 (Dog ownership) analysis of variance was carried out to assess whether differences in SOP scores were significantly different across the five testing time points. Data violated the assumptions of sphericity as demonstrated through Mauchly's test (X^2

(9) = 22.186, *p* =.008) therefore degrees of freedom are corrected using Huynh-Feldt estimates of sphericity. A significant main effect of time was revealed [*F* (4.000, 348) = 123.422, *p* < 0.001, η_p^2 = .587] which showed that children's overall SOP the Stroop tasks improved significantly over time with more items completed in the time allowed. Planned comparisons revealed significant decreases in processing speed between each of the consecutive test times with more items completed (see Table 37).

Table 37
SOP, planned comparisons for significant main effect of time (Bonferroni; p = .0125)

Paired samples	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Pre-post intervention	-.060	.074	-8.264	104	.000
Post intervention to 6-week	-.053	.075	-7.220	104	.000
6-week to 6-month	-.020	.070	-2.960	100	.004
6-month to 1-year	-.055	.078	-7.026	97	.000

No significant main effect for condition [*F* (2, 87) = 1.064, *p* = .350, η_p^2 = .024] or interactions for condition with time was revealed for SOP [*F* (8.00, 348.00) = .596, *p* = .781, η_p^2 = .014]. Planned comparisons were carried out to investigate any effects for condition on SOP. All children's SOP in the dog interventions decreased significantly between all consecutive tests, whilst those in the relaxation and control conditions also saw a significant decrease in the SOP apart from between the 6-week and 6-month test times (see Table 38 and Figure 16).

Table 38
SOP, planned comparisons for significant main effect of time with condition (Bonferroni; p = .004)

Condition	Paired samples	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Dog	Pre-post intervention	-0.058	0.073	-4.98	38	.000
	Post intervention to 6-week	-0.048	0.077	-3.91	38	.000
	6-week to 6-month	-0.032	0.066	-3.02	37	.000
	6-month to 1-year	-0.050	0.080	-3.85	37	.000
Relaxation	Pre-post intervention	-0.068	0.081	-5.32	39	.000
	Post intervention to 6-week	-0.044	0.083	-3.36	39	.002

	6-week to 6-month	-0.026	0.077	-2.04	36	.049
	6-month to 1-year	-0.047	0.078	-3.63	35	.001
Control	Pre-post intervention	-0.051	0.068	-3.82	25	.001
	Post intervention to 6-week	-0.075	0.058	-6.61	25	.000
	6-week to 6-month	0.003	0.065	0.24	25	.815
	6-month to 1-year	-0.069	0.085	-4.04	24	.000

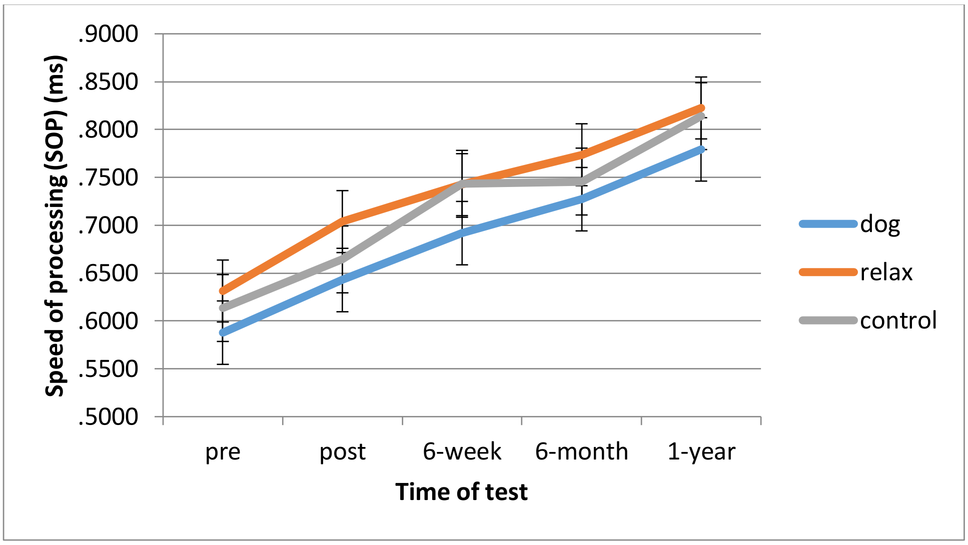

Figure 16. SOP planned comparisons for condition with time, whereby higher scores represent more items completed in time allowed (Bonferroni; p = .004)

As no interactions for gender and dog ownership were revealed, these are now omitted from the one-to-one and group analysis. The following results are analysed using 5 (time) x 3 (condition) analyses of variance with repeated measures on the factor of time. Violation of sphericity was tested and corrections used as appropriate (see Appendix 10).

6.4.4.1 One-to-one sessions: Speed of processing (SOP)

Children's overall speed of processing changed significantly over the school term, as demonstrated by a significant main effect of time [F (3.785, 230.907) = 109.162, $p < 0.001$, η_p^2 = .642] with more items completed per second over time. Planned comparisons showed significantly faster speeds of processing for children in the one-to-one sessions between all consecutive test times apart from the 6-week to 6-assessments which failed to reach significance once adjusted (see Table 39).

Table 39
SOP *one-to-one intervention sessions: planned comparisons for significant main effect of time (Bonferroni; p = .0125)*

Paired samples	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Pre-post intervention	-.059	.067	-7.327	67	.000
Post intervention to 6-week	-.059	.069	-7.079	67	.000
6-week to 6-month	-.019	.067	-2.311	65	.024
6-month to 1-year	-.053	.081	-5.264	63	.000

No significant main effect for condition [F (2, 61) = 2.477, p = .092, η_p^2 = .075] or interaction of time with condition [F (7.571, 230.907) = 1.300, p = .247, η_p^2 = .041] were present within the SOP one-to-one session data. Planned comparisons for children who took part in the these sessions revealed mixed results, with those in the dog condition significantly faster between the 6-week and 6-month test time only. This was in contrast to children who took part in relaxation and control conditions who had significantly faster processing between all consecutive time points apart from the 6-week to 6-month assessments (see Table 40 and Figure 17).

Table 40
SOP one-to-one, planned comparisons for significant main effect of time with condition (Bonferroni; p = .004)

Condition	Paired samples	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Dog	Pre-post intervention	-.048	.073	-2.94	19	.008
	Post intervention to 6-week	-.037	.093	-1.78	19	.090
	6-week to 6-month	-.057	.062	-4.14	19	.001
	6-month to 1-year	-.036	.089	-1.79	19	.089
Relaxation	Pre-post intervention	-.082	.059	-6.46	21	.000
	Post intervention to 6-week	-.063	.054	-5.48	21	.000

	6-week to 6-month	-.010	.063	-0.71	19	.486
	6-month to 1-year	-.051	.065	-3.44	18	.003
Control	Pre-post intervention	-.051	.068	-3.82	25	.001
	Post intervention to 6-week	-.075	.058	-6.61	25	.000
	6-week to 6-month	.003	.065	0.24	25	.815
	6-month to 1-year	-.069	.085	-4.04	24	.000

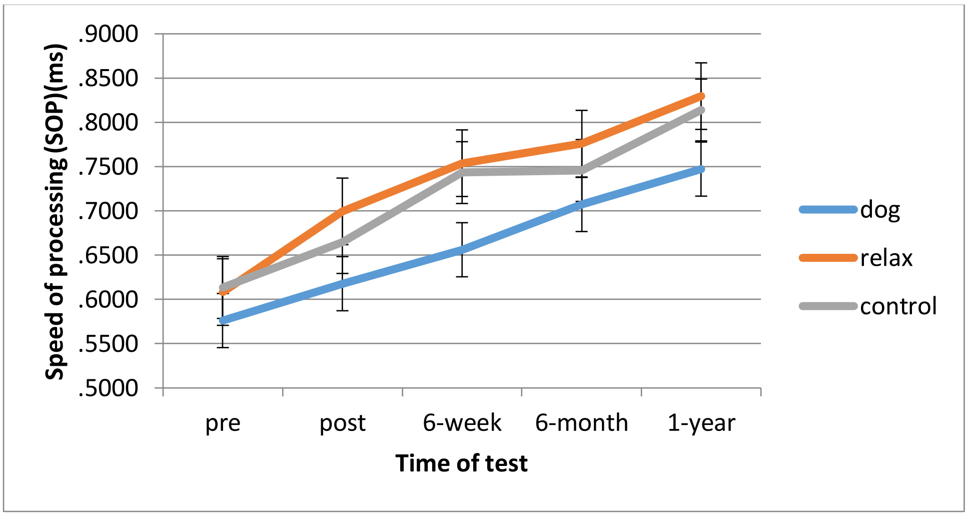

Figure 17. SOP, planned comparisons for one-to-one sessions of condition with time, whereby higher scores represent more items completed in time allowed (Bonferroni; p = .004)

6.4.4.2 Group sessions: Speed of processing (SOP)

A significant effect for time on SOP was revealed [F (3.630, 214.182) = 82.081, $p < 0.001$, η_p^2 = .582] showing that children's overall speed of processing the Stroop task changed significantly over course of the study for those children taking part in group sessions. Planned comparisons revealed significant differences in scores between all consecutive assessments, all apart from the 6-week to 6-month test times (see Table 41).

Table 41
SOP *group intervention sessions: planned comparisons for significant main effect of time*

Paired samples	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Pre-post intervention	-.056	.078	-5.793	64	.000
Post intervention to 6-week	-.057	.076	-6.064	64	.000

6-week to 6-month	-.014	.072	-1.557	62	.125
6-month to 1-year	-.060	.078	-6.057	60	.000

No significant main effect [F (2, 59) = .058, p = .944, η_p^2 = .002] or interactions for condition [F (7.260, 214.182) = 1.137, p = .341, η_p^2 = .037] for SOP in the group sessions were revealed. To investigate predicted effects, this result was inspected further with planned comparisons and indicated that children in the dog condition became faster between all consecutive test times apart from the 6-week to 6-month period. This pattern of results was also present for children who acted as controls. Interestingly, this was in contrast to the children who took part in group relaxation interventions who showed no improvement in the speed of processing across comparisons (see Table 42).

Table 42
SOP group, planned comparisons for significant main effect of time with condition (Bonferroni; p = .004)

Condition	Paired samples	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Dog	Pre-post intervention	-.066	.073	-4.063	19	.001
	Post intervention to 6-week	-.063	.056	-5.024	19	.000
	6-week to 6-month	-.011	.064	-.717	18	.483
	6-month to 1-year	-.063	.066	-4.188	18	.001
Relaxation	Pre-post intervention	-.054	.099	-2.374	18	.029
	Post intervention to 6-week	-.028	.107	-1.144	18	.268
	6-week to 6-month	-.043	.087	-2.116	17	.049
	6-month to 1-year	-.036	.091	-1.691	17	.109
Control	Pre-post intervention	-.051	.068	-3.817	25	.001
	Post intervention to 6-week	-.075	.058	-6.614	25	.000
	6-week to 6-month	.003	.065	.236	25	.815
	6-month to 1-year	-.069	.085	-4.036	24	.000

6.4.4.3 Summary: Fruit Stroop, Speed of Processing (SOP)

Children's speed of processing (SOP) was calculated to represent the number of items completed per second within the time allocated to carry out the task. All children showed significantly faster processing of the Fruit Stroop over time, whereby more items were completed per second over each consecutive test time. Whilst significant main effects of condition or interactions of condition with time were not present for SOP, planned comparisons based on session type of either one-to-one or group interventions, differences emerged across the data. For children who took part in the one-to-one dog sessions, SOP items only increased significantly between the 6-week and 6-month test times. This was in direct contrast to those in the relaxation and control conditions who made improvements between all other test times but not the 6-week to 6-month assessments. Different patterns of results were revealed for children who took part in group interventions with both the dog and control groups showing significantly better SOP at all test times except between the 6-week and 6-month assessments, in contrast to those who took part in relaxation interventions who showed no significant effects for SOP across any comparisons. As with all previous analysis of the Fruit stroop task, no main effects or significant interactions of gender or dog ownership were present for SOP.

6.5 Discussion: Fruit Stroop

In line with previous research involving Stroop tasks, errors in this study were extremely rare (Lovett, 2005; Okuzumi et al., 2015). Raw data scores revealed that the incongruent colour task elicited the most errors but these were not significantly greater than in the congruent or control tasks. Of interest is that intervention conditions of dog, relaxation and control did not impact on error rates showing that AAI did not lend advantage in this area.

Interference scores were calculated for congruency which involved comparison of congruent fruit versus incongruent fruit stimuli, or for colour processing which involved comparison of the neutral colour task versus incongruent fruit task. The latter took into account the time to process colour regardless of semantic fruit information. Nevertheless, overall children's processing of congruency under both conditions was not significantly different over each testing time, demonstrating that task difficulty remained equal over the school year. This finding does not support the hypothesis that general learning and maturation effects will be expected in all cognitive measures. As with the previous analysis for BAS, the Fruit Stroop task also confirmed no main effects or interactions for gender and dog ownership on processing of the task. Additionally, the factors of gender and dog ownership did not have an effect on results of the Fruit Stroop over time.

As described earlier, in order to test the feasibility of working with therapy dogs within the classroom environment and cost effectiveness of such interventions, sessions were conducted as either one-to-one or in small groups. Whilst significant interactions of time with condition was revealed for congruency scores for those taking part in one-to-one sessions, and for colour processing in the group interventions, comparisons for both failed to reach significance across consecutive test times. Additionally, the comparison of scores from baseline to the 1-year tests failed to reach significance thereby confirming that AAI did not have an effect on colour processing within the Fruit Stroop task.

Speed of processing (SOP) is an important factor in cognitive processing. Children showed significant improvements in the speed of processing the Fruit Stroop over the one year study and between all consecutive test times. This result in line with previous literature showing the increase in processing with age (Duell et al., 2018). One-to-one interventions involving dogs, showed significant effects on SOP items between the 6-week and 6-month test times, whilst those in the relaxation and control conditions made improvements between all other test times except between the 6-week to 6-month tests. Those in the dog group interventions and those who acted as controls had significantly improved SOP at all test times except between 6-week and 6-months. Interestingly, the results from the group relaxation interventions stand out as they did not have an effect on the SOP across any comparisons. This finding contradicts the view that SOP increases with age due to working memory processes (Duell at al., 2018) but could potentially allow a deeper insight into the effects of th different interventions on executive function and working memory processes, For example, this result could potentially be seen to evidence of the calming effect of relaxation by slowing response times in the processing the Stroop task, and a beneficial effect of AAI which increases response times.

Again, results for SOP were not affected by gender or dog ownership with no main effects or interactions for either factor within any of the analysis.

The Fruit Stroop represents a measure of children's inhibitory processing which is not explicitly taught in school and develops slowly with age. In order to test the effects of AAI on a measure which is being actively tutored in school and which has specific application within wider educational activities, children's maths ability was assessed next.

6.6 Results: Effects of AAI on maths scores

The effects of dog-assisted intervention on a maths task were carried out next and represented a practical school activity. The following tables 43-45 show the results by intervention condition. Double the number of boys had a pet dog, than those who did not, whereas dog ownership status was equal across girls. All children's maths scores showed an increase from baseline to the one-year tests, except girls in the relaxation condition with a dog at home who showed a decline in scores at the one-year assessment time. All boys with a pet dog had higher baseline scores than those without a dog. This was also the case for girls in the relaxation and control conditions, however girls with a dog at home and who were in the dog condition had lower pre-intervention scores than those who did not have a pet dog (see Tables 43 - 45)

Table 43
Mean and standard deviation data for children in dog intervention, maths scores split by gender and dog ownership.

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	6	2.666	2.732
		Post-intervention	6	2.000	2.449
		6-week	6	3.000	2.828
		6-month	6	4.166	3.020
		1-year	6	3.333	2.503
	No dog	Pre-intervention	12	1.666	1.557
		Post-intervention	12	1.666	1.614
		6-week	12	2.083	2.609
		6-month	12	2.41	1.621
		1-year	12	3.166	2.855
Female	Dog	Pre-intervention	12	0.916	1/164
		Post-intervention	12	1.416	1.564
		6-week	12	1.833	1.585
		6-month	12	1.333	1.557
		1-year	12	2.333	2.674
	No dog	Pre-intervention	8	1.375	1.995
		Post-intervention	8	2.125	2.587
		6-week	8	2.625	2.386
		6-month	7	3.285	2.811
		1-year	7	3.571	2.992

Table 44
Mean and standard deviation data for children in relaxation-intervention, maths scores split by gender and dog ownership.

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	7	3.142	2.193
		Post-intervention	7	2.571	2.299

		6-week	7	3.285	0.951
		6-month	7	3.714	2.429
		1-year	7	4.142	3.236
	No dog	Pre-intervention	9	1.666	1.658
		Post-intervention	9	2.666	2.061
		6-week	9	3.333	2.291
		6-month	9	4.000	2.738
		1-year	9	4.888	3.822
Female	Dog	Pre-intervention	8	1.875	2.232
		Post-intervention	8	1.625	1.597
		6-week	8	2.500	1.927
		6-month	8	2.000	1.603
		1-year	7	1.000	1.914
	No dog	Pre-intervention	11	1.272	0.646
		Post-intervention	12	1.500	1.000
		6-week	12	2.333	2.103
		6-month	10	3.100	0.737
		1-year	11	3.181	1.877

Table 45
Mean and standard deviation data for children in control-condition, maths scores split by gender and dog ownership.

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	4	2.250	1.258
		Post-intervention	4	3.250	2.872
		6-week	4	3.000	1.414
		6-month	4	4.500	3.316
		1-year	4	3.500	3.109
	No dog	Pre-intervention	13	1.076	1.656
		Post-intervention	13	2.615	2.433
		6-week	13	2.846	2.034
		6-month	13	3.461	2.633
		1-year	13	3.615	2.399
Female	Dog	Pre-intervention	4	1.250	1.258

	Post-intervention	4	2.500	1.290
	6-week	4	1.750	2.362
	6-month	4	2.250	1.500
	1-year	4	3.000	2.708
No dog	Pre-intervention	5	0.800	1.095
	Post-intervention	7	1.285	1.380
	6-week	7	1.714	3.302
	6-month	7	2.142	1.463
	1-year	6	2.333	2.065

Initial inspection of the data using the Shapiro-Wilk statistic revealed that assumptions of normality are violated for the baseline maths scores (W = .694 $p < .001$). Visual inspection shows the data to be severely violated with skewness of 3.20 (SE = .239) and kurtosis of 16.682 (SE = .474). Data was checked for potential outliers with N = 3 children being 2.5SD above the mean. N = 3 outliers were removed. Data still violates the assumptions of normality (W = .872, p < .001), skewness of .232 (SE = .243) and kurtosis of -1.185 (SE = .481). Data was log transformed (Log10) with +1 constant to account for zero count scores; data tends to normality, and so parametric tests are employed to analyse the maths results.

An initial one-way ANOVA was also conducted to assess whether maths data was comparable across schools. No significant effect of school was returned in relation to maths scores, [F (3, 101) = 1.528; p = .212, η_p^2 = .045] showing that the number of maths problems completed correctly were not differentially impacted by the school attended. School was therefore excluded from further analysis.

6.6.1 All children: Maths

A 5(Time) x 3(Condition) x 2(Gender) x 2 (Dog ownership) analysis of variance was carried out initially to assess maths scores over time and whether these were affected by intervention condition, gender or dog ownership. Mauchly's test shows that the data meets the assumptions of sphericity (X^2 (9) = 10.766, p = .292). A significant effect of time was revealed [F (4,332) = 11.810, p < .001, η_p^2 = .125] showing that children's mathematical ability improved significantly over time as demonstrated through the number of maths problems solved correctly. Planned comparisons revealed significant differences in scores between pre and post interventions but not between any other consecutive test times (see Table 46).

Table 46
Maths ability, *planned comparisons for significant main effect of time (Bonferroni; p = .0125)*

SOP, paired samples by time	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Pre-post intervention	-.075	.293	-2.558	98	.012
Post intervention to 6-week	-.052	.277	-1.920	101	.058
6-week to 6-month	-.056	.283	-1.966	98	.052
6-month to 1-year	.001	.272	.054	96	.957

A significant main effect of gender was present within the data [F (1, 83) = 4.291, p = .041, η_p^2 = .049] showing that boys (M = 2.87) performed significantly better than girls (M = 2.05). Figure 18 below illustrates this finding.

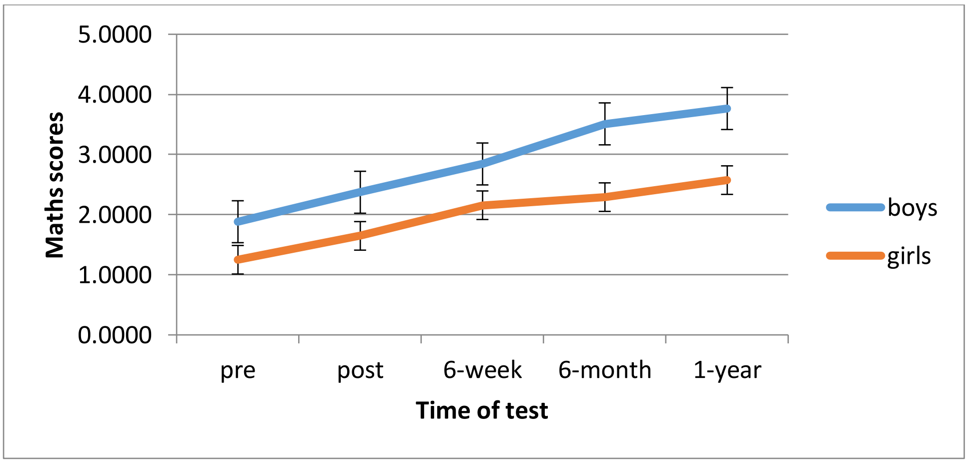

Figure 18. Maths ability, main effect of gender

No significant main effect [F (2, 83) = .439, *p* = .646, η_p^2 = .010] or interaction of time with condition [F (8, 332) = 1.122, *p* = .348, η_p^2 = .026] was revealed for children's maths scores. Planned comparisons to explore the predicted effects of interventions on scores revealed that children in all conditions showed a significant increase in maths scores between the baseline and 1-year test time (dog: (*t* (37) = -4.454, *p* < .001), relax: (*t* (36) = -3.984, *p* < .001), control: (*t* (23) = -5.027, *p* < .001)). When assessed based on consecutive test times across the length of the study only children in the control condition improved significantly immediately after intervention (*t* (25) = -3.566, *p* = .001). Maths scores did not significantly improve across consecutive time points for any other conditions therefore neither dog nor relaxation sessions shared any effects (see Figure 19).

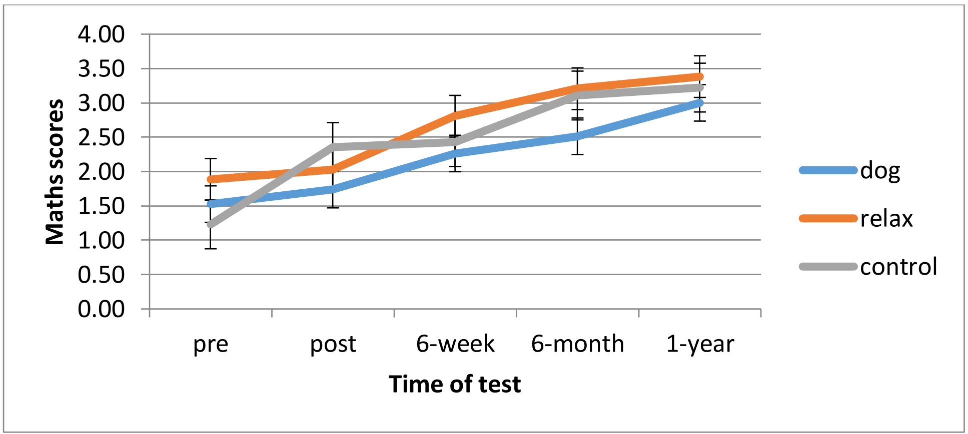

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Figure 19. Maths scores, planned comparisons for condition with time (Bonferroni; p = .004)

A significant interaction for time with dog ownership was also revealed [(F (4, 332) = 2.453, *p* = .046, η_p^2 = .029]. Post-hoc paired samples showed that only children without a dog made significant improvement in maths scores between the pre-post intervention tests. This effect was irrespective of intervention condition which the child took part in, and no other consecutive test times reached significance (see Table 47 below).

Table 47
Maths ability, *planned comparisons for significant main effect of time with dog ownership (Bonferroni; p = .006)*

Dog ownership	Maths paired samples by time	*M*	*SD*	*t*	*df*	Sig (2-tailed)

	Pre-post intervention	-.025	.304	-.535	40	.596
	Post intervention to 6-week	-.079	.300	-1.690	40	.099
	6-week to 6-month	.000	.292	.008	40	.993
	6-month to 1-year	.019	.339	.359	39	.721
No dog	Pre-post intervention	-.110	.282	-2.988	57	.004
	Post intervention to 6-week	-.034	.261	-1.040	60	.303
	6-week to 6-month	-.095	.272	-2.679	57	.010
	6-month to 1-year	-.010	.216	-.384	56	.702

As effects for gender and dog-ownership were found within the maths data, these are therefore included within the following analysis to assess the effect of session-type (one-to-one and group). The following analyses of one-to-one and group, both involve 5(Time) 3 (Condition) x 2 (Gender) x 2 (Dog-ownership) analyses of variance with repeated measures on the factor of time. Violation of sphericity was tested and corrections used as appropriate (see Appendix 10).

6.6.1.1 One-to one sessions: Effects of AAI on maths scores

A significant effect of time was revealed [F (4,192) = 10.390, p < 0.001, η_p^2 = .178] showing that children's mathematical ability improved significantly over time when taking part in one-to-one intervention sessions. Planned comparisons revealed a significant increase in scores between pre- and post- intervention, and the 6-week to 6-month test time.

Table 48
Maths ability one-to-one sessions: planned comparisons paired samples t-tests for significant main effect of time (Bonferroni; p = .0125)

Maths, paired samples by time	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Pre-post intervention	-.169	.260	-4.928	62	.000
Post intervention to 6-week	.012	.262	.373	65	.711
6-week to 6-month	-.087	.263	-2.652	63	.010
6-month to 1-year	.033	.260	1.017	61	.313

No main effect for condition [F (2, 48) = .700, p = .502, η_p^2 = .028] and no interaction of time with condition [F (8,192) = 1.237, p = .280, η_p^2 = .049] were found. Planned comparisons of maths scores from baseline to the 1-year test time showed that children who had taken part in the dog (t (19) = -3.428, p =. 003) and control conditions (t (24) = -4.414, p <. 001) made significant improvements in maths scores whilst those in the relaxation interventions did not (t (15) = -1.011, p = .328) (Bonferroni; p = .016). Comparison of test scores across consecutive time points revealed that only the children who acted as controls made significant improvements in maths immediately after intervention (t (25) = -3.566, p =. 001) (see Table 49).

Table 49
Maths ability one-to-one sessions: planned comparisons paired samples t-tests of time with condition (Bonferroni; p = .004)

Condition	Maths paired samples by time	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Dog	Pre-post intervention	-.153	.298	-2.296	19	.033
	Post intervention to 6-week	.036	.300	.536	19	.598
	6-week to 6-month	-.079	.328	-1.084	19	.292
	6-month to 1-year	-.030	.294	-.458	19	.652
Relaxation	Pre-post intervention	-.142	.226	-2.586	16	.020
	Post intervention to 6-week	-.018	.235	-.335	17	.741
	6-week to 6-month	-.036	.160	-.918	15	.373
	6-month to 1-year	.156	.263	2.300	14	.037
Control	Pre-post intervention	-.181	.259	-3.566	25	.001
	Post intervention to 6-week	.014	.256	.300	27	.766
	6-week to 6-month	-.121	.261	-2.457	27	.021
	6-month to 1-year	.012	.215	.308	26	.761

No further main effects or interactions for gender or dog ownership were present within the maths data for children taking part in one-to-one intervention sessions (see Appendix 11).

6.6.1.2 Group sessions: Maths

A significant effect of time was that children's mathematical ability improved significantly over time sessions revealed [F (4,192) = 7.645, p < 0.001, η_p^2 = .137]. Planned comparisons revealed that while maths scores increase significantly over the course of the study between the baseline and 1-year time point (t (59) = -5.520, p <. 001), only the post intervention to 6-week test time showed a significant increase in maths for children in the group sessions (t (63) = -2.598, p =.012) (see Table 50).

Table 50
Maths ability group intervention sessions: post-hoc paired samples t-tests for significant main effect of time

Maths ability , paired samples by time	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Pre-post intervention	-.032	.303	-.831	61	.409
Post intervention to 6-week	-.089	.277	-2.598	63	.012
6-week to 6-month	-.053	.295	-1.433	62	.157
6-month to 1-year	-.025	.258	-.785	61	.436

No significant main effect of condition [F (2, 48) = .687, p = .508, η_p^2 = .028] or interaction of time with condition [F (8,192) = 1.807, p = .078, η_p^2 = .070] were revealed within the group data for maths. Once again planned comparisons were run to investigate the effect of interventions further. Assessment from baseline to the 1-year test time (Bonferroni; p = .016) revealed that children who took part in the group relaxation condition (t (17) = -2.716, p = .015) and those who acted as controls (t (24) = -4.414, p < .001) made significant improvements in maths scores, whilst those who took part in the group dog interventions did not (t (16) = -2.159, p = .046). Assessments carried out over consecutive test times revealed results in line with the one-to-one sessions, whereby children who acted as controls made significant improvements in maths scores immediately after intervention (t (25) = -3.566, p = .001) (see Table 51).

Table 51

Maths ability group sessions: planned comparisons paired samples t-tests of time with condition (Bonferroni; p = .004)

Condition	Maths paired samples by time	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Dog	Pre-post intervention	.089	.339	1.117	17	.280
	Post intervention to 6-week	-.165	.268	-2.625	17	.018
	6-week to 6-month	.004	.329	.052	16	.959
	6-month to 1-year	-.047	.290	-.680	16	.506
Relaxation	Pre-post intervention	.062	.237	1.119	17	.279
	Post intervention to 6-week	-.176	.275	-2.725	17	.014
	6-week to 6-month	-.001	.307	-.024	17	.981
	6-month to 1-year	-.062	.291	-.92	17	.374
Control	Pre-post intervention	-.181	.259	-3.566	25	.001
	Post intervention to 6-week	.014	.256	.300	27	.766
	6-week to 6-month	-.121	.261	-2.457	27	.021
	6-month to 1-year	.012	.215	.308	26	.761

Also in this group intervention sessions, a main effect of gender was revealed [F (1, 48) = 13.716, p = .001, η_p^2 = .222] with boys (M = 3.37) performing better at maths than girls (M = 1.72). No significant interactions of condition, gender or dog–ownership with time are present within the data.

6.7 Summary and discussion: Maths

In order to test the effect of the dog-assisted intervention on a practical school task which children typically perform within the classroom environment, they were asked to complete a maths task. The task was purposely designed to create an element of stress by being sufficiently difficult, and children were timed to solve as many problems as possible within two minutes. Overall, children’s maths scores improved significantly over the length of the one-year study regardless of the intervention condition which children took part in. Once data was analysed separately, children who took part in the one-to-one sessions showed significant increases in maths scores up to the 6-week assessment, in contrast to children in the group sessions who only showed improvement between the 6-week and 6month test times.

Overall, children's scores showed an increase in the number completed correctly up to the 6 month time point. There was no change between the 6 month and 1 year times as results stay constant and do not improve further between these two testing points. As with the cognitive testing in the BAS above this result would be expected, given that children are attending school and maths is a key skill that is actively taught on a daily basis through the National Curriculum. The plateau in maths results at the 6-month time point supports the view that learning and cognitive development are not linear processes within the child and show a natural fluctuation of development (Ayoub & Fischer, 2006; Reilly, 2000).

Children in the dog interventions had a significant increase in maths scores across the length of the project but equally this result was also the case for children in the relaxation and control conditions. Closer inspection using planned comparisons showed that dog interventions did not have an effect on children's maths ability beyond results for children who took part in the relaxation and control conditions when assessment was carried out for scores over consecutive test times across the study. In contrast, only children who acted as controls made a significant improvement in maths scores immediately after intervention. As previous research is not published which has specifically tested the effects of AAI and relaxation interventions on maths scores future research will need to replicate these findings. However, it can be concluded that the intervention did not improve maths scores in children

Of interest, is that children without a dog at home showed significantly improved maths scores between the pre-post intervention tests. This effect was irrespective of the intervention condition which children had taken part in during the study. This result is contrary to the hypothesis that there would be no difference in scores based on children's dog ownership status and is also unique in the sense that this has not been shown in previous research.

A significant difference in maths ability was evident between girls and boys with boys consistently scoring significantly higher on the maths task than girls. This result is consistent with the long-reported performance data that boys outperform girls in Key Stage 2 (KS2) maths (Bedard & Cho, 2010; Ganley & Lubienski, 2015; Department for Children, Schools and Families (DCSF), 2009; Department for Education and Skills, (DfES) 2007). However, this result is worthy of further investigation as the education system in the UK has worked hard to close this gender gap (DCSF, 2009; DfES, 2007). Performance data for 2018 (DfE) shows that 75% of boys met the expected standard in maths at KS2, whilst 76% of girls met the expected standard, slightly outperforming boys by one percentage-point. Children's mathematics performance within this study does not appear to reflect national UK statistics.

The tasks above represented the effects of AAI on non-verbal abilities. To get a fuller picture of the effects of dog-assisted intervention on children's wider academic function the following results chapter will assess effects of dog-assisted-intervention on areas involving language abilities.

CHAPTER 7: Effects of AAI on Categorisation and Language Abilities

7.1 Measures overview for categorisation and language abilities

As an underpinning attribute of language processing, a reaction time categorisation task was presented to children and assessed in relation to AAI (as used by Gee et al., 2012). The task included the processing of animacy as a factor of image properties. Reaction time (RT) measures include a degree of a child's detection, processing and response to stimuli. In addition to assessing the effects of AAI on categorisation, further standardised measures were used to assess children's grammar and comprehension.

As highlighted in the introduction, the effect of AAI on language production and comprehension abilities are largely unexplored. Consequently, children's language function, specifically, syntactic formulation and sentence comprehension, were also assessed through the Assessment of Comprehension and Expression (ACE) standardised toolkit (for test details, see Chapter 5).

7.1.1 Data management, structure and analysis of categorisation and language.

Categorisation abilities were measured using a speed reaction time task comprised of images pre-assessed for properties specifically relating to animacy. The Assessment of Comprehension and Expression (ACE) was utilised to assess children's language skills; specifically Sentence Comprehension and Syntactic Formulation (grammar).

Scores were calculated for all children in all conditions, and assessed separately depending on whether children took part in one-to-one or group interventions. Descriptive statistics were reported in the first instance. Data was initially analysed to test for potential differences in scores between schools using one way analysis of variance (ANOVA) before running repeated measures ANOVAS for all children on the effects of Time x Condition (dog / relax / control) x Gender (boys/girls) x Dog ownership (dog owner/ non-dog owner), with repeated measures on the factor of time. Categorisation data was analysed using separate ANOVAs for gender and dog ownership due to lack of entries for cell values once data was split for animacy; Time x Condition (dog / relax / control) x Gender (boys/girls) Time x Condition (dog / relax / control) x Dog ownership (dog owner/ non-dog owner).

To investigate the effects of AAI further, data was then analysed in more detail depending on whether children took part in one-to-one interventions or within a small group. Planned comparisons were conducted using paired samples t-tests and post-hoc tests conducted as appropriate throughout. All results were adjusted using Bonferroni corrections.

7.2 Results: Categorisation and Language

Categorisation: Inspection of the pre-intervention data revealed that assumptions of normality were violated for all reaction time (RT) data across all categories of stimuli (see Appendix 10). Within the present study, responses of less than 200 milliseconds (ms) were excluded as these would be classed as an anticipatory responses and would therefore not represent meaningful data (Greenberg, Holder, Kindschi & Deputy, 2018). No cut-off for longer decision making was applied and all other data included. Due to the nature of RT data, it is more often than not, positively skewed. Debate exists around the removal of outliers using cut-off methods, the application of parametric analysis or transformation of the data (Ratcliffe, 1993; Whelan, 2008). It was therefore decided that whilst cut-off methods may maintain the highest power for analysis of RT data, they need to be made arbitrarily and can often produce bias in results. The second best method for maintaining power with RT data is through transformation of the data (Ratcliffe, 1993). The current data set was therefore transformed, tended to normal, and parametric tests used to analyse the dataset. Degrees of freedom are corrected using Huynh-Feldt estimates of sphericity; Mauchly's (χ^2 (9) = 17.794, p = .038). *Language:* Assumptions of normality are violated for sentence comprehension with skewness -.026 (SE.236) and kurtosis .298 (SE .467), Shapiro-Wilk (W= .975, p = .047).

As data for sentence comprehension shows only moderate violation, parametric tests will be used for analysis of the data. Data for syntactic formulation with skewness .507 (SE = .236) and kurtosis .663 (SE .467), Shapiro-Wilk (W = .950 p = .001) shows violated assumptions of normality. Analysis of both skewed, and log transformed (Log10) data showed no significant differences in output so the original data is presented in order to be comparable with the syntactic formulation analysis and parametric tests applied.

7.2.1 All children: Categorisation.

Demographic data for categorisation was split based on intervention condition, gender and dog ownership status. Boys in the dog and relaxation conditions have faster reaction times (RT) if they have a dog at home, than those who do not, whereas boys in the control condition have similar RTs regardless of dog ownership status. Girls in the dog condition have similar RTs regardless of dog ownership, whilst those in the relaxation and control conditions have faster RTs if they do not have a dog at home, although this is more pronounced in the control condition. Dog-ownership status was unequal across gender, with one third of boys having a dog at home, compared with equal numbers of girls (Table 52).

Table 52

Means and standard deviations for children's categorisation of images split by condition, gender and dog ownership demographics

Condition	Gender	Dog Owner	*N*	*M*	*SD*
Dog	Male	Dog	7	1394.95	254.74
		No Dog	13	1516.82	-295.05
	Female	Dog	13	1325.57	223.42
		No Dog	9	1374.46	225.11
Relax	Male	Dog	5	1063.21	288.65
		No Dog	11	1457.39	252.74
	Female	Dog	7	1336.97,	299.87

		No Dog	11	1288.71	261.63
Control	Male	Dog	6	1418.78	245.72
		No Dog	11	1416.31	268.28
	Female	Dog	4	1430.29	349.08
		No Dog	8	1177.83	185.72

To investigate the effects of AAI on categorisation and whether differences in RTs to processing of animacy were significantly affected by condition or gender a 2 (Time) x 2 (Animacy) x 3 (Condition) x 2 (Gender) analysis of variance was carried out with repeated measures on the factor of time. Mauchly's test showed that data met the assumptions of sphericity for time (χ^2 (9) = 12.491, p = .187). A highly significant main effect was revealed for time [F (4, 320) = 9.787, p < .001, η_p^2 = .109] whereby children's reaction times to the processing of animacy changed significantly over the course of the 1-year study, with time accounting for a large amount of variance within the model. Planned comparisons showed that reaction times decreased significantly immediately after intervention (t (104) = 4.869, p < .001) and between the post-intervention and 6-week tests (t (104) = 3.206, p = .002) but not past 6-weeks between further consecutive test times. Whilst no significant interaction of time with condition was present within the analysis, planned comparisons revealed showed that children in all conditions became more efficient in processing animacy between the baseline and 1-year test times; dog (t (42) = 4.225, p < .001), relax (t (33) = 4.203, p < .001), control (t (42) = 2.791, p = .010). Analysis of processing between each consecutive test time revealed that only the dog (t (42) = 3.378, p = .002) and relaxation conditions (t (33) = 3.691, p = .001) produced significant improvements immediately after intervention but not at subsequent time points. The no treatment control group failed to show any improvements (see Figure 20 and Table 53).

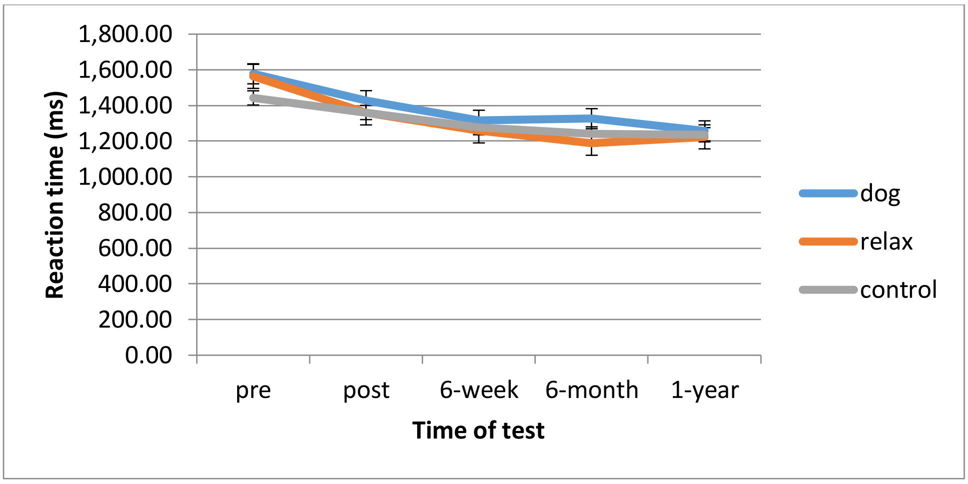

Figure 20. All children, effect of condition with time

Table 53

All children, planned comparisons of condition over time (Bonferroni; p = .003)

Condition	Time of test	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Dog	Pre-post	.039	.076	3.378	42	.002
	Post -6-week	.035	.103	2.249	42	.030
	6-week -6-month	-.002	.159	-.112	42	.911
	6-month – 1-year	.025	.130	1.307	42	.198
Relaxation	Pre-post	.057	.090	3.691	33	.001
	Post -6-week	.032	.129	1.466	33	.152
	6-week -6-month	.034	.160	1.250	33	.220
	6-month – 1-year	-.020	.139	-.845	33	.404
Control	Pre-post	.019	.085	1.216	27	.234
	Post -6-week	.032	.086	1.980	27	.058
	6-week -6-month	.012	.072	.907	27	.372
	6-month – 1-year	.008	.142	.301	27	.766

Inanimate images (M = 1567.2ms) were processed significantly slower than animate ones (M = 1261.3ms) as demonstrated by a significant main effect of animacy [F (1, 80) = 90.988, $p < .001$, $\eta_p^2 = .532$]; partial eta squared also showed that animacy accounts for large amount of variance within the model. An interaction of time with animacy [F (4, 320) = 20.495, $p < .001$, $\eta_p^2 = .204$] confirmed the above results, and showed that RTs to process inanimate images was slower at all test times up the 6-month assessment. An interaction occurs between the 6-month and 1-year time point whereby animate images are processed slower than inanimate images at the 1-year test time (see Figure 21).

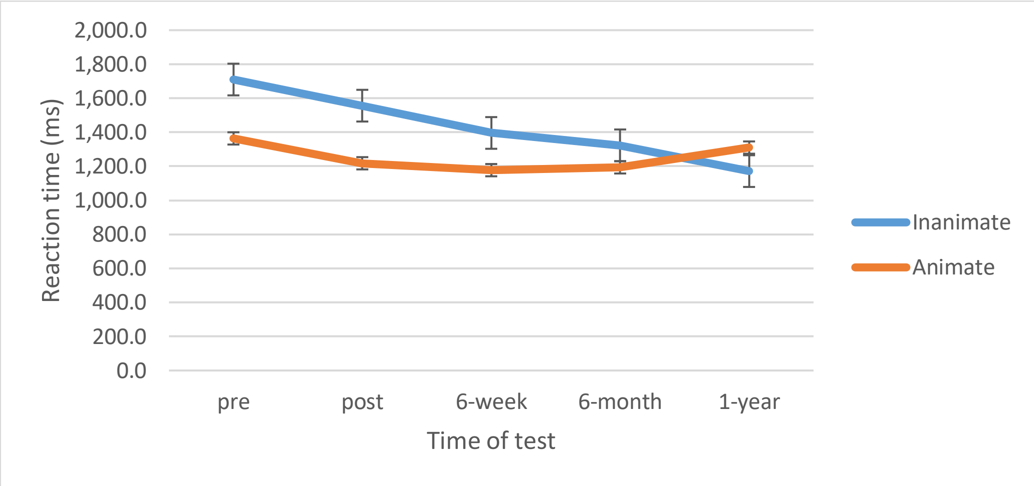

Figure 21. All children, significant interaction of time with animacy

Animacy with condition [F (2, 80) = 3.8.31, p = .026, η_p^2 = .087] produced a significant interaction with post hoc tests showing no significant differences between conditions for either animate (F (2, 104) = .497, p = .610, η_p^2 = .010) or inanimate images (F (2, 104) = .569, p = .568, η_p^2 = .011). Paired samples t-tests showed significant differences in animacy for children in all conditions; dog (t (42) = -11.290, p = < .001), relax (t (33) = -10.926, p = < .001), control (t (27) = -7.013, p = < .001) . Inspection of the mean data showed that scores were more similar across conditions for animate (dog M = 1292.6ms; relax M = 1245.7ms; control M = 1232.4ms) than inanimate images (dog M = 1601.2ms; relax M = 1577.1ms; control = 1503.0ms) (see Figure 22).

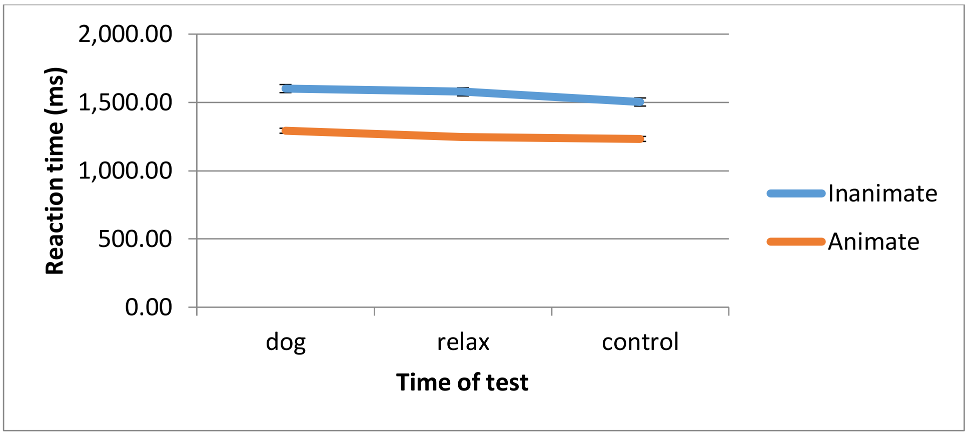

Figure 22. All children, significant interaction of animacy with condition

No further main effects or interactions for condition or gender with animacy were found. To test the effects of AAI on animacy with dog ownership status of children, a further 5 (Time) x 2 (Animacy) x 3(Condition) x 2 (Dog ownership) analysis of variance with repeated measures on the factor of time was conducted. Results confirmed the previous analysis for animacy and gender, and no main effects [F (1, 80) = .007, p = .931, η_p^2 = .000] or interaction for dog ownership with time [F (4, 320) = .007, p = 1.185, η_p^2 = .317] or animacy [F (1, 80) = .005, p = .945, η_p^2 = .000] were found. Data for dog-ownership was therefore collapsed over the following analyses carried out for session type of one-to-one and group interventions. Both assessments involve 5(time) x 2 (animacy) x 3 (condition) x 2 (gender) analyses of variance with repeated measures on the factor of time. Violation of sphericity was tested and corrections used as appropriate (see Appendix 10).

7.2.1.1 One-to-one sessions: Categorisation

A significant main effect of time was found for children attending one-to-one intervention sessions [*F* (4.000, 192.00) = 7.306, *p* =.001; η_p^2 = .132] with RTs becoming significantly faster between the pre- and post-intervention (*t* (66) = 4.288, *p* < .001) and the post- to 6-week test times (*t* (66) = 2.695, *p* = .009) but not between other consecutive test times. No main effect of condition [*F* (2, 48) = 1.456, *p* =.243; η_p^2 = .057] or interaction of time with condition [*F* (8.00, 192.00) = 1.004, *p* =.435; η_p^2 = .040] were found. Planned comparisons to investigate the effects of intervention per condition further. Children in the relaxation condition showed a significant reduction in RTs between the pre- and post-intervention tests (*t* (17) = 4.363, *p* <. 001). No other paired comparisons were significant across time for any condition. Comparisons for each condition from baseline to the 1-year test time revealed that overall children became significantly faster at categorising animacy. Children in the dog condition (*t* (21) = 4.335, *p* <. 001) showed a stronger effect than children in the relaxation (*t* (17) = 2.828, *p* = .012) and control conditions (*t* (26) = 2.846, *p* = .009). Children in the dog condition also had an increase in RTs at the 6-month test time although no difference between conditions was present [*F* (2, 104) = .456, *p* = .635, η_p^2 = .009] (see Figure 23).

Figure 23. One-to-one sessions, time with condition for animacy

Reaction times for animacy showed a significant main effect [*F* (1, 48) = 90.573, *p* <.001; η_p^2 = .654] with animate images being processed faster (M =1572.3ms) than inanimate images (M = 1269.8ms) and animacy accounting for a large amount of variance within the model. A significant interaction between time and animacy [*F* (4.00, 192.00) = 11.488, *p* <.001; η_p^2 = .193] demonstrated that RTs based on animacy were significantly different at baseline (*t* (66) =-9.769, $p < .001$), post-intervention (*t* (66) = -8.868, $p < .001$), 6-week (*t* (63) = -5.632, $p < .001$), and 6-months (*t* (61) = -6.311, $p < .001$) test time with inanimate images being processed faster than inanimate ones. This pattern changes at the 1-year test time with animate and inanimate images showing no difference in processing time (*t* (66) =1.464, $p < .148$) (see Figure 24).

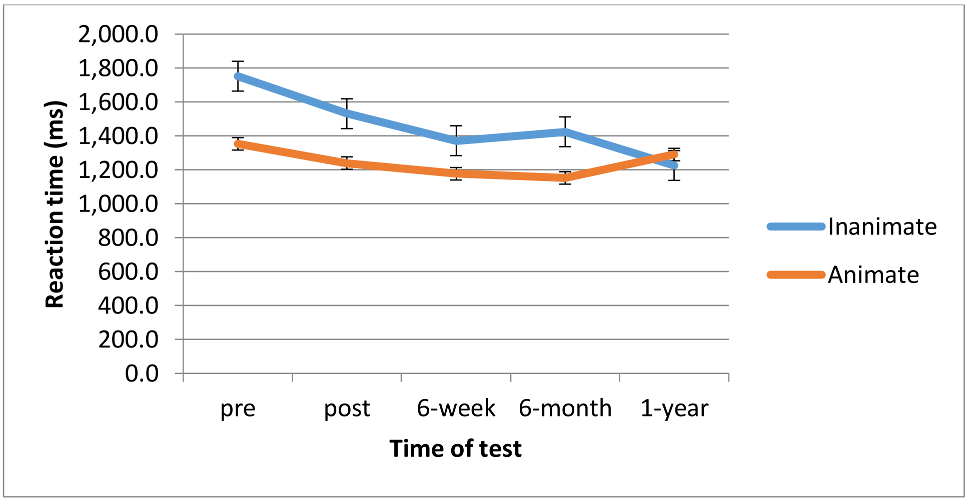

Figure 24. One-to-one sessions, significant interaction between time with animacy (Bonferroni; $p = .01$)

7.2.1.2 Group sessions: Categorisation

A significant main effect of time was found for children attending group intervention sessions [F (4, 180) = 7.708, p =.001; $\eta_p^2 = .146$] with RTs becoming significantly faster between the pre- and post-intervention (*t* (62) = 3.259, $p < .001$) but not between other consecutive test times. Overall, RT's became significantly faster over the course of the study between the baseline and 1-year tests (*t* (62) = 4.985, $p < .001$). No main effect of condition [F (1, 45) = .548, p =.582; $\eta_p^2 = .024$] or interaction of time with condition [F (8, 180) = .814, p =.591; $\eta_p^2 = .035$] were found therefore planned comparisons were conducted and showed that children in the relaxation condition had the most efficient processing (*t* (15) = 4.065, p = .001), followed by the children in the control condition (*t* (25) = 3.165, p = .004), with those in the dog condition showing the worst performance (t (20) = 2.565, p = .018) (see Figure 25).

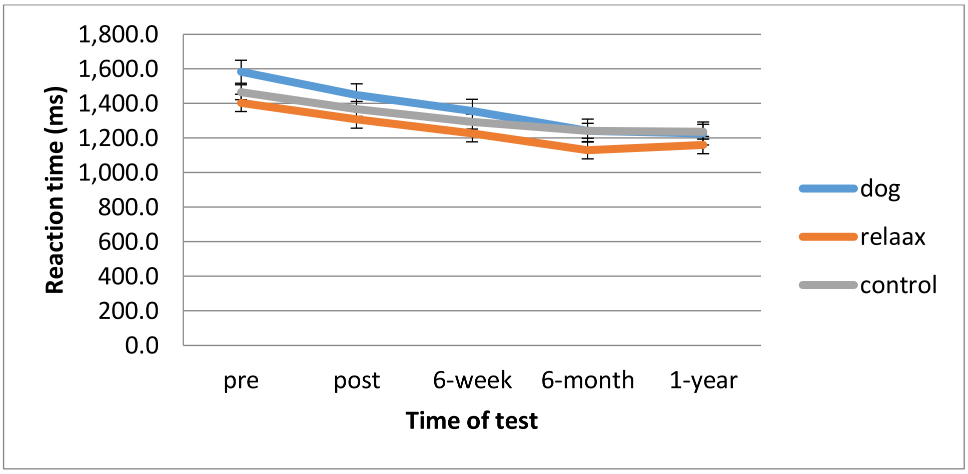

Figure 25. Group intervention, condition over time (Bonferroni; p = .004)

A main effect for animacy was also present [F (1, 45) = 30.988, p <.001; η_p^2 = .408] with animate images (M = 1243.7ms) being processed significantly faster than inanimate ones (M = 1541.6ms). An interaction of animacy with condition [F (2, 45) = 6.545, p = .003; η_p^2 = .225] was present, with post hoc paired samples t-tests showing that all RTs were significantly different based on animacy (dog (t (20) = -7.681, p < .001); relax (t (15) = -8.596, p < .001); control (t (25) = -6.415, p < .001). No significant differences existed between intervention condition for animate or inanimate images (see Figure 26).

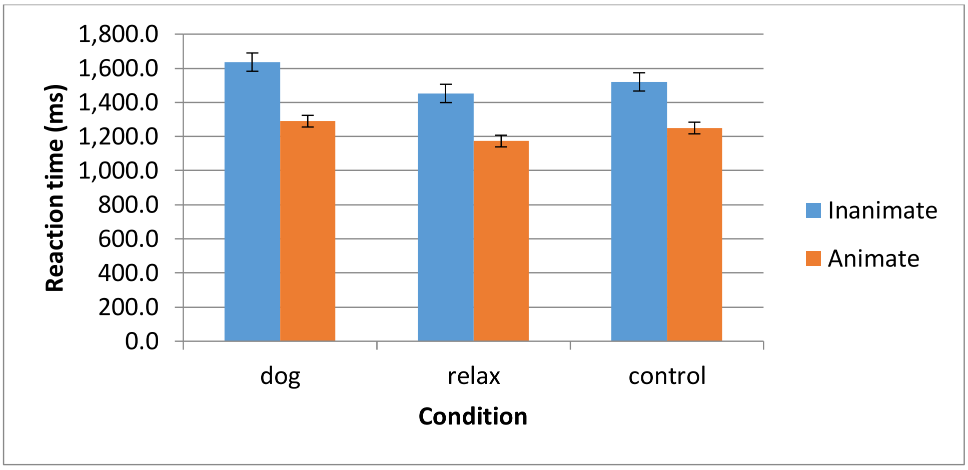

Figure 26. Group sessions, significant interaction of animacy with condition

Time with animacy was revealed as a significant interaction [F (4, 180) = 25.015, p < .001; η_p^2 = .357] with all inanimate images having slower reaction times than animate images up to the 6-week test time. An interaction occured whereby no differences are found for the processing of animacy at the 6-month test time, followed by a reverse pattern with animate images showing greater RTs at the 1-year test point (see Figure 27 and Table 54 below).

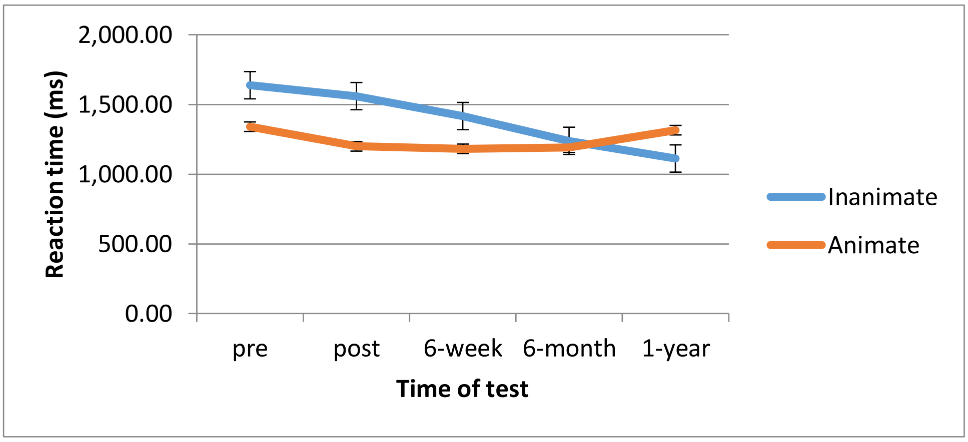

Figure 27. Group interventions, significant interaction of time with animacy (Bonferroni; p =.01)

Table 54

Group interventions, significant interaction of time with animacy

Time of test	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Pre-intervention	-.083	.096	-6.876	62	.000
Post-intervention	-.108	.108	-7.926	62	.000
6-week	-.075	.084	-7.094	61	.000
6-month	-.018	.134	-1.060	56	.294
1-year	.072	.131	4.137	55	.000

A further interaction of time with animacy and condition [F (8, 180) = 5.551, $p <$ .001; $\eta_p^2 = .198$] revealed that children in the dog condition had significant differences in RTs with animate images processed faster than inanimate images, apart from at the 6-month test time, with a reverse pattern at the 1-year test point. Children in the control condition also show significant differences in RTs to process animacy apart from at the 1-year test time. In contrast, children in the relaxation condition show an interaction occurring at the 6-month test time with animate images showing slower RTs at the 1-year assessment, however differences are only significant at the post-intervention test time (see Figure 27 and Table 55 below)

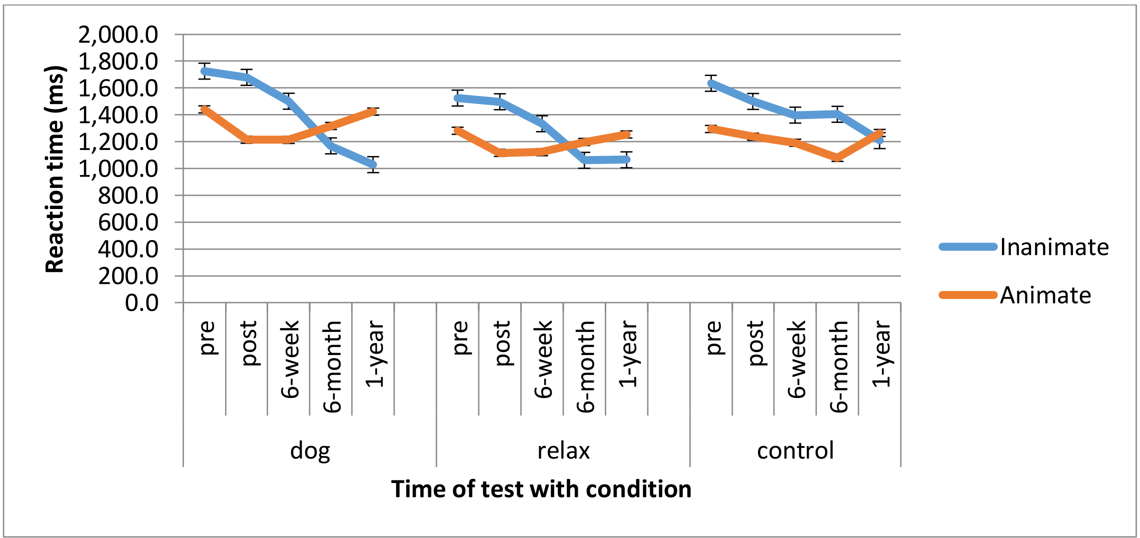

Figure 27. Group interventions, significant interaction of time with condition and animacy (Bonferroni; p =.003)

Table 55
Group interventions, significant interaction of time with animacy and condition (Bonferroni; p = .003)

Condition	Time of test	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Dog	Pre-intervention	-.079	.098	-3.693	20	.001
	Post-intervention	-.133	.116	-5.246	20	.000
	6-week	-.092	.075	-5.624	20	.000
	6-month	.053	.078	2.964	18	.008
	1-year	.133	.142	3.968	17	.001
Relaxation	Pre-intervention	-.070	.093	-3.029	15	.008
	Post-intervention	-.119	.128	-3.709	15	.002
	6-week	-.065	.101	-2.608	15	.020
	6-month	.054	.073	2.810	13	.015
	1-year	.067	.106	2.549	15	.022
Control	Pre-intervention	-.095	.099	-4.879	25	.000
	Post-intervention	-.082	.085	-4.913	25	.000
	6-week	-.067	.080	-4.227	24	.000
	6-month	-.118	.133	-4.351	23	.000
	1-year	.026	.123	1.003	21	.327

A significant interaction of time with condition and gender was revealed [F (8, 180) = 2.100, p =.038; η_p^2 = .085]. Post hoc tests carried out across time and gender did not reach significance once adjusted (Bonferroni; p = .003). Further analysis to test for differences between condition at specific test times of baseline, 6-month and 1-year for boys, in addition to baseline, post-intervention and 6-weeks for girls also did not reach significance (see Appendix 12). Observation of the mean data showed that boys RTs became more similar between the post-intervention and 6-week test time regardless of condition they took part in, RTs become faster at the 6-month test and then see an increase to the 1-year test time with those in the relaxation condition having faster RTs across the study. Those in the dog condition show the slowest RTs at the beginning of the study however those in the control group showed the slowest times at the 1-year test point. In contrast girls RTs reduced to the 6-month test time with mean data showing that RTs between conditions do not become more similar with time. Children in the dog condition show the slowest times across the length of the study whilst the 6-month test time sees the relaxation and control interact, with the control children having the fastest RTs at the 1-year test time (see Figure 29). Significant differences do not exist between conditions at baseline for either boys [F (2, 32) = .360, p =.701; η_p^2 = .023] or girls [F (2, 29) = .801, p =.459; η_p^2 = .056] or between condition at each successive time point (see Appendix 12).

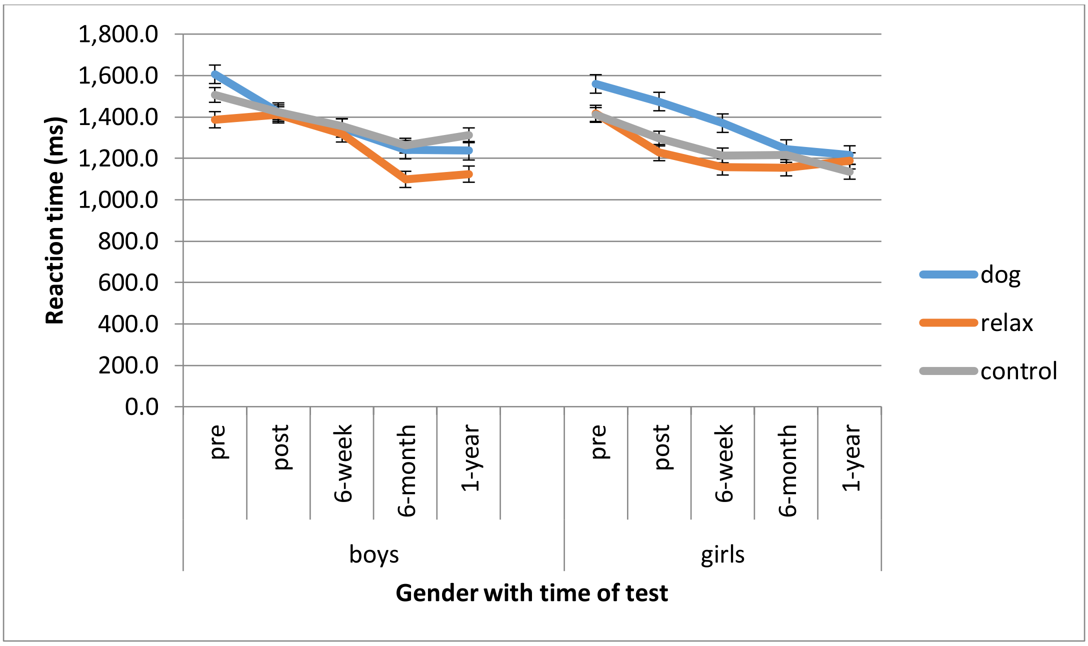

Figure 29. Group sessions, significant interaction of time with condition and gender (Bonferroni; p = .003)

7.2.1.3 Summary: Categorisation

As expected children's processing of animacy showed a significant improvement with time, with images being processed faster over the course of the longitudinal study. A main effect of animacy and an interaction of animacy with time also demonstrated that children processed animate images faster than inanimate ones. Once data was analysed based on session type, children showed no significant difference in processing animacy at the 6-month test times. This pattern then reversed with inanimate images being processed faster than animate ones at the one year time point.

As the interest of the study was to investigate the effects of AAI on children's cognition, planned comparisons were therefore run in response to a lack of significant interactions of condition with time. Children in the dog and relaxation conditions made significant improvements immediately after intervention but comparisons after this time point failed to reach significance. Scores for those in the control condition failed to reach significance between any of the test times, including immediately after intervention. However, overall the assessment of data from baseline to the one-year tests showed that children in all conditions made significant improvements in RTs. The assessment of data based on session type revealed differences across conditions. Whilst those in the individual one-to-one sessions made significant improvements in all conditions, the dog intervention showed the strongest result, followed by the control and lastly the relaxation intervention. In comparison, those children in group interventions who took part in the dog interventions failed to make improvements once adjusted for significance, whilst the children in the relaxation showed the strongest results followed by those acting as controls.

An effect of condition with animacy also reflected the above results with children in all conditions showing a significant difference in processing times between animate and inanimate images in all conditions. Children in the dog condition processed images the slowest and those in the relaxation condition processed images the fastest. Whilst this result is present in the initial analysis of all data combined, analysis of differences between one-to-one and group sessions revealed a further interaction of time with condition and animacy but demonstrating that this effect was present across the one year study with difference greater for those children who took part in the group intervention sessions.

Only group interventions resulted in interactions of condition with gender, with both girls and boys in the dog condition showing more similar RTs between animate and inanimate images, than those in the relaxation and control conditions. A further interaction of time with animacy and gender also demonstrated that both boys and girls RTs to process animate and inanimate images differed significantly up to the 6-week test time. Differences based on gender then occur whereby boys show no difference in processing animacy at the 6-month and 1-year test times. In contrast, girls show no difference at the 6-month test time but then show a further difference at the 1-year assessment.

Dog ownership status of children was not found to be a significant factor in the processing of animacy. The lack of main effects and interactions also showed that dog ownership status did not preferentially impact on the effects of the AAI and relaxation interventions either.

7.2.3 Discussion: Categorisation

On the whole, the hypothesis that the dog-assisted intervention would show significant improvements compared to children in the relaxation and control condition was partially supported for the categorisation task. The improvement in RTs between the baseline and post-intervention test times demonstrated that children in both the dog and relaxation conditions performed equally well in the processing of animacy, in contrast to those in the control condition who did not. Whilst this result supports the hypothesis that overall children in the no treatment control condition would show the least improvement, it fails to align with the prediction that relaxation sessions would be less effective than the dog sessions. The improvement in processing after taking part in dog-assisted sessions is in line with previous research which was carried out with AAI (Gee et al., 2012b), however, it is not possible to assert this finding to the equal improvement demonstrated in the relaxation condition when looking at children overall. Further detailed assessment of the data based on the type of session of either one-to-one or group interventions produces a different pattern of results. Children taking part in the one-to-one sessions showed the predicted pattern of results reported above. However, children who took part in the group interventions showed the slowest RTs in the dog interventions compared to relaxation sessions which demonstrated the strongest effects. The effect of children's group dynamics on performance must therefore be considered in the interpretation of these results. It could be that the social interactions affected children's attentional performance in the Stroop due to wider neuromodulatory systems which play an important role in regulating the top-down and bottom-up processes involved in attention (Banich et al., 2000; Corbetta, Patel & Shulman, 2008; Pardo, Pardo, Janer & Raichle, 1990). Also linked with this, the quality and intensity of the sessions may have been less effective in the group sessions for AAI, but also for those in relaxation sessions who had additional distractions and may not have concentrated on the meditation as well as those in one-to-one sessions.

As expected, the main effect of time in the processing of animacy across all children supported the hypothesis that learning and maturational effects would impact on data collection. In contrast, interactions of time with condition were not evident, as discussed above, therefore positive longitudinal effects of AAI on categorisation, and processing of animacy specifically, cannot be supported past the immediate post-intervention test times.

Children within this study processed animate images significantly faster than inanimate ones, which is in line with previous research (Calvillo & Hawkins, 2016; Calvillo & Jackson, 2013, Gee et al., 2012b; New, Cosmides and Tooby, 2007) suggesting an attentional bias for animacy (Yang, Wang, Yan, Zhu, Chen & Wang, 2012). It is of interest to also note that previous research regarding children's exposure to animals (in the form of dog ownership) (Geerdts, Van de Walle & LoBue, 2015; Prokop, Prokop & Tunnicliffe, 2008) did not extend to the results within this study by assisting children in the processing of animacy over and above those in the relaxation condition.

The hypothesis that no differences would be found based on dog ownership status of children was supported for the processing of animacy.

The hypothesis that no differences would exist based on gender was supported for children's processing of the categorisation task, with the absence of a main effect. Whilst an interaction for gender with condition was revealed for the processing of animacy after taking part in group interventions, no consistent pattern of results for either factor was present. Significant differences based on gender across condition did not exist at the pre-intervention test time, and all children had comparable processing at the one-year assessment showing that children's allocation to a particular condition did not preferentially influence categorisation abilities.

As categorisation abilities can be seen to underpin language learning, results are now analysed which assess the specific areas of sentence comprehension and syntactic formulation.

7.3 Assessment of Sentence Comprehension and Syntactic Formulation tests

The effect of AAI on children's language ability was assessed through standardised tests from the Assessment of Comprehension and Expression (ACE) . An initial one-way analysis of variance was conducted to assess whether data collection through the ACE at baseline was comparable across schools. A non-significant effect of school was returned in relation to sentence comprehension [F (3, 104) = 2.130; p = .101, η_p^2 = .059], however, baseline syntactic formulation scores reveal an effect for school [F (3, 104) = 3.256; p = .025, η_p^2 = .088] demonstrating that differences in baseline performance on the task were potentially related to school of attendance.

7.3.1 All children: Sentence comprehension (SC)

The results investigating the effects of AAI on children's sentence comprehension are firstly reported for all children then data was split based on whether the child took part in one-to-one or group intervention sessions. Overall, children's sentence comprehension scores increase between the pre-intervention assessment and the 1-year test sessions. For most groups of children the improvement in sentence comprehension does not follow a linear pattern of increase, with scores often showing a peak in improvement around the 6-month test time, followed by a small decrease in scores. Dog ownership status of the children was unequal across gender, with dog, and none dog owners approximately equal across girls, whilst two thirds of boys had no dog, compared with one third who did. The following tables 56-58 show the results by intervention condition.

Table 56
Sentence comprehension: Mean and standard deviation data for dog intervention, split by gender and dog ownership

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	6	7.833	2.136
		Post-intervention	6	10.166	1.602
		6-week	6	10.166	2.401
		6-month	6	11.333	2.338
		1-year	6	9.833	1.169
	No dog	Pre-intervention	14	8.500	2.738
		Post-intervention	14	8.714	2.893
		6-week	14	9.928	2.092
		6-month	14	10.357	2.844
Female	Dog	1-year	14	10.142	2.143
		Pre-intervention	11	9.272	2.004
		Post-intervention	11	11.090	2.773
		6-week	11	10.545	2.114
		6-month	11	9.909	2.022
		1-year	11	10.454	2.621
	No dog	Pre-intervention	8	7.875	1.885
		Post-intervention	8	10.250	2.815
		6-week	8	10.870	3.270
		6-month	7	9.714	2.811
		1-year	8	12.000	2.449

Table 57
Sentence comprehension; Mean and standard deviation data for relaxation intervention, split by gender and dog ownership

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	8	9.6250	1.30247
		Post-intervention	8	11.6250	2.82527
		6-week	8	11.2500	2.31455
		6-month	7	11.7143	2.36039
		1-year	8	13.1250	1.88509
	No dog	Pre-intervention	10	8.4000	1.77639
		Post-intervention	9	10.1111	3.98260
		6-week	10	10.9000	2.33095
		6-month	10	10.9000	1.85293
		1-year	10	12.2000	1.68655
Female	Dog	Pre-intervention	9	9.5556	3.46811
		Post-intervention	9	9.7778	3.56293
		6-week	9	11.0000	2.87228
		6-month	9	9.8889	2.31541
		1-year	8	11.2500	3.24037
	No dog	Pre-intervention	12	7.5000	1.88294
		Post-intervention	12	9.4167	3.91868
		6-week	12	11.5000	3.87298
		6-month	10	12.0000	1.94365
		1-year	11	11.7273	2.90141

Table 58
Sentence comprehension; Mean and standard deviation data for control condition, split by gender and dog ownership

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	4	6.7500	4.03113
		Post-intervention	4	12.2500	0.95743
		6-week	4	9.5000	0.57735
		6-month	4	10.7500	4.03113
		1-year	4	13.0000	2.58199
	No dog	Pre-intervention	12	11.0000	2.86039
		Post-intervention	12	12.1667	2.75791
		6-week	12	10.7500	2.89592
		6-month	12	11.6667	2.77434
		1-year	12	12.7500	3.41454
Female	Dog	Pre-intervention	4	11.5000	3.00000
		Post-intervention	4	12.0000	2.94392
		6-week	4	11.5000	3.31662
		6-month	4	12.2500	3.77492
		1-year	4	11.7500	0.95743
	No dog	Pre-intervention	7	10.0000	2.82843

	Post-intervention	7	10.4286	3.55233
	6-week	7	12.1429	3.02372
	6-month	7	11.2857	2.69037
	1-year	6	12.1667	2.40139

To investigate the effects of AAI on sentence comprehension a 5 (Time) x 3 (Condition) x 2 (Gender) x 2 (Dog ownership) analysis of variance was conducted, with repeated measures on the factor or time. Assumptions of sphericity were met (χ^2 (9) = 11.970, *p* = .215). A significant main effect of time showed children's sentence comprehension scores (SC) [*F* (4, 344) = 25.880, *p* < .001, η_p^2 =.231] improved over the 1-year study; partial eta squared showed that time accounted for a large amount of variance within the model. Planned comparisons revealed that children's scores increase significantly immediately after intervention between pre and post-intervention time points (*t* (103) = -5.132, *p* < .001) (see Table 59).

Table 59
Sentence comprehension, planned comparisons tests for significant effect of time (Bonferroni; p = .0125)

Planned comparisons by time	*M*	*SD*	*t*	*df*	*p*
Pre – Post	-1.480	2.942	-5.132	103	.000
Post – 6-week	-.403	2.931	-1.405	103	.163
6-week – 6-month	-.029	2.406	-.124	100	.902
6-month – 1-year	-.676	2.329	-2.891	98	.005

No significant main effect of condition [*F* (2, 86) = 2.779, *p* = .068, η_p^2 =.061] or interaction of time with condition [*F* (8, 344) = 1.387, *p* = .201, η_p^2 =.031] were found within the SC data. Children's scores increased significantly between the baseline and 1-year test time for all conditions; dog (*t* (37) = -5.469, *p* < .001), relax (*t* (36) = -7.947, *p* < .001), control (*t* (25) = -3.094, *p* = .005) with control showing the least effect. Planned comparisons were run to explore the effects of interventions which showed that significantly increased scores for sentence comprehension were present between the pre-and post-intervention test times for children who had taken part in the dog condition (t (38) = -4.102, p < .001), no other pairs of consecutive test times reached significance (see Figure 30). All children's scores improved immediately after intervention, but whereas the children in the relaxation and dog conditions continued to increase to the 6-week tests, those in the control condition show a decline in scores. Children in the control condition show overall higher scores at baseline but the lack of main effect for condition showed that scores are not significantly different between groups overall No other main effects or two-way interactions were significant.

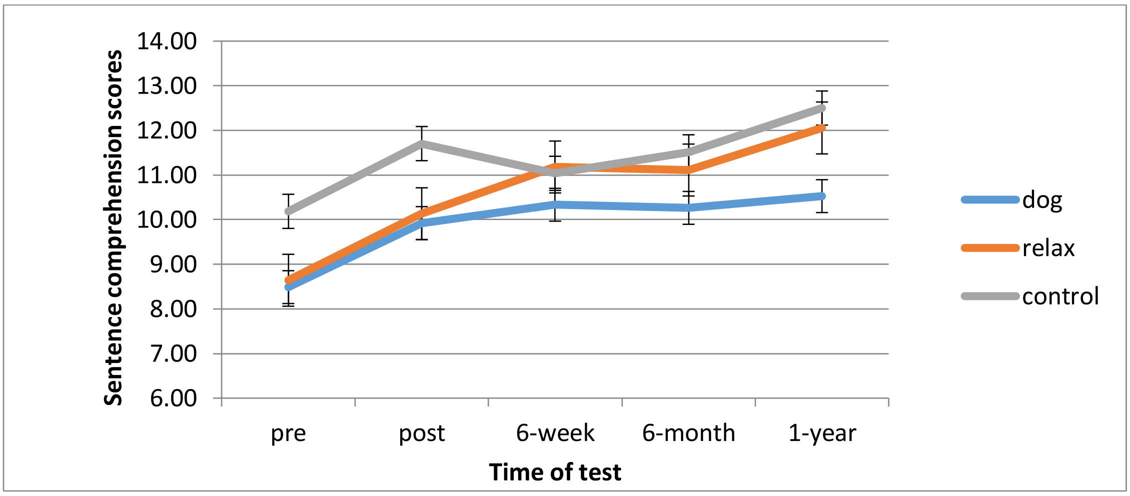

Figure 30. *Sentence comprehension (SC), planned comparisons for time with condition over consecutive test times (Bonferroni; p = .004)*

A significant three-way interaction of time, condition and gender was also revealed for children's sentence comprehension scores [F (8, 344) = 2.250, p = .024, η_p^2 =.050] with these combined factors accounting for a small amount of variance within the model. Interactions occur across the three conditions with girls in the dog condition showing higher scores than boys to the 6-week test time and then a reduction below those of boys' scores at the 6-month assessment. Boys show higher scores in the relaxation group with girls' surpassing these at the 6-week test time to create an interaction. This pattern then reverses with girls showing lower SC scores at the 1-year assessment. Post-hoc tests assessing possible differences at the 6-week and 1-year time points were not significant. Girls in the control condition show a steady increase in SC scores to the 1-year test time, with boys showing an increase at the post intervention test time, followed by a decline and further increase at the 6-week and 6-month tests. Post-hoc paired samples t-tests with data split by condition and gender showed significant improvement in SC scores for boys in the dog condition between the baseline and 6-months (t (19) = -4.138, p = .001) and for girls in the dog condition between pre- and post-intervention (t (18) -5.129, $p < .001$), pre- and 6-weeks (t (18) -4.327, $p < .001$), and pre- and 1-year (t (17) -4.466, $p < .001$). Boys in the relaxation condition showed improved scores between the pre- and 1-year tests (t (20) -4.367, $p < .001$) and girls made significant improvements between the pre and 6-week tests (t (18) -4.327, $p < .001$) and the pre to 1-year (t (18) -4.857, $p < .001$) (see Figure 31 below). No significant differences existed between groups based on condition and gender at each of the test times (see Appendix 13)

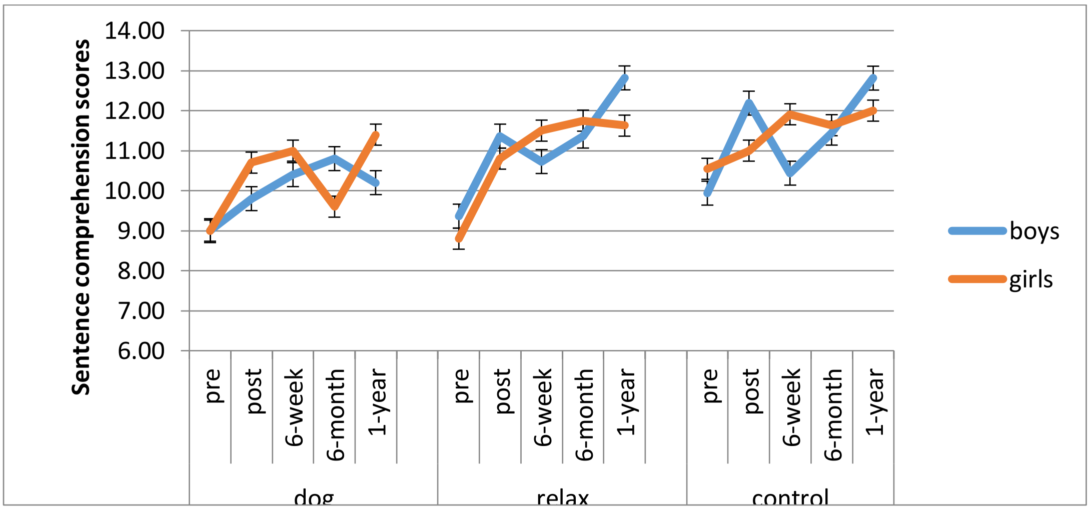

Figure 31. Sentence comprehension (SC), three-way-interaction of time, condition and gender (Bonferroni; p = .001)

A further three-way-interaction of time, gender and dog ownership was found [F (4, 344) = 3.926, p = .004, η_p^2 =.044] with these combined factors accounting for a small amount of variance within the model. Interaction was present due to boys who had a dog at home showing improved SC scores beyond those of other children at the post-intervention test time, which is then followed by a reverse pattern at the 6-week test; this is in contrast to the scores of girls without a dog at home who show an increase at this test time. This reverses again at the 6-month assessments with all girls showing worse scores than the boys who are dog owners. Further post-hoc analyses to assess the differences in the none-dog owning children at the 6-month and 1-year test times failed to reveal significant differences between the groups. Post-hoc paired samples t-tests revealed that boys with a dog at home made significant improvements between the pre- and post-intervention (t (17) = -3.901, p = .001) and the pre and 1-year test times (t (17) = -4.420, p = .001). Boys with no dog at home showed significantly improved scores at a later point in the year between the pre- and 6-month (t (35) = -3.606, p = .001) and pre- and 1-year tests (t (35) = -4.583, $p < .001$). In contrast girls who did not have a dog at home made significant improvements between the pre- and 6-weeks (t (26) = -6.497, $p < .001$), pre and 6-months (t (23) = -5.145, $p < .001$) and pre- and 1-year (t (23) = -7.299, $p < .001$). Once adjusted for significance, girls who were dog owners failed to make any significant improvements across any of the test times. In addition, further post-hoc tests looking at the differences between boys and girls who were not dog owners at the 6-month and 1-year assessment times failed to reach significance (see Figure 32 below).

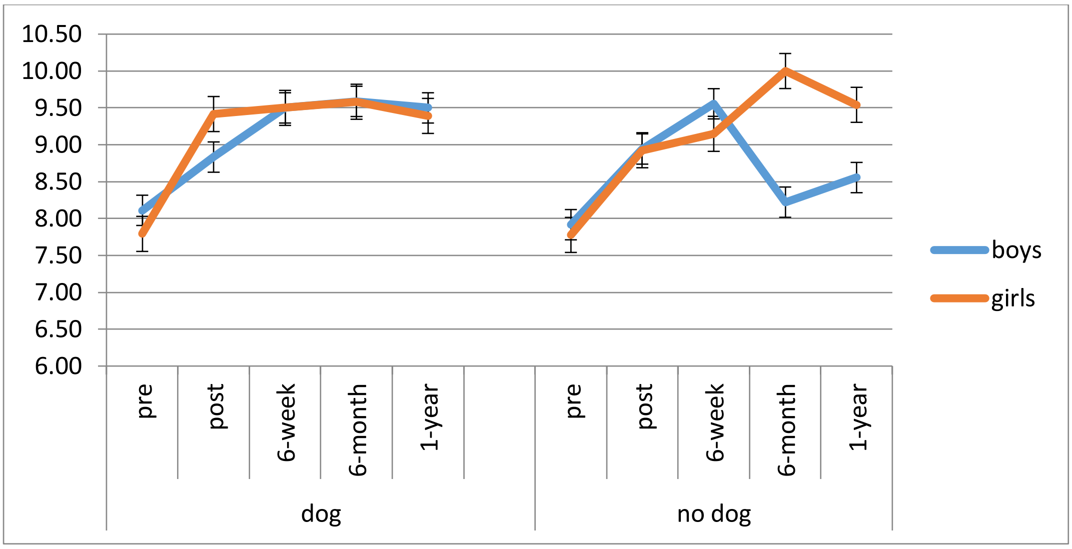

Figure 32. Sentence Comprehension (SC), three-way-interaction for time, gender and dog ownership

No other main effects or interactions with time, gender and dog ownership were present for sentence comprehension scores. The following SC results for each of the one-to-one and group intervention sessions will be carried out using 5 (time of test) x 3 (condition) x 2 (gender) x 2 (dog ownership) analyses of variance with repeated measures on the factor of time. Violation of sphericity was tested and corrections used as appropriate (Appendix 10).

7.3.1.1 One-to-one sessions: Sentence comprehension (SC)

A highly significant main effect of time was revealed [F (4, 208), = 15.354, $p < 0.001$, η_p^2 =.228] with improved scores over time in all children. Partial Eta Squared indicates that time accounts for a large amount of variance within the model. Planned comparisons revealed that children's scores increased significantly immediately after intervention, between pre and post-intervention (see Table 60). All other scores for children in the one-to-one sessions remain relatively stable over all other time points, with a small decrease in scores at the 6-week test time.

Table 60

Sentence Comprehension, One-to-one sessions, planned comparisons for main effect of time (Bonferroni; p = .0125)

Time of test	*M*	*SD*	*t*	*df*	*p*
Pre to post	-1.588	2.978	-4.397	67	.000
Post to 6-week	.132	2.567	.425	67	.672
6-week to 6-month	.075	2.525	-.244	65	.808
6-month to 1-year	-.812	2.356	-2.759	63	.008

No main effect of condition [F (2, 52), = 1.331, p = .273, η_p^2 =.049] or interaction for time with condition were found [F (8, 208), = .398, p = .921, η_p^2 =.015]. All conditions resulted in improved scores between the baseline and 1-year tests; dog (t (19) = -3.715, p = .001), relax (t (18) = -5.337, p < .010), control (t (25) = -3.094, p = .005). Planned comparisons were conducted in order to further investigate the effect of AAI on SC scores. None of the paired comparisons between consecutive test times reached significance for children's SC scores when taking part in one-to-one intervention sessions (see Table 61).

Table 61

Sentence Comprehension, One-to-one sessions, planned comparisons for time with condition, (Bonferroni; p = .004)

Condition	Time of Test	*M*	*SD*	*t*	*df*	*p*
Dog	Pre to post	-1.250	2.268	-2.465	19	.023
	Post to 6-week	-.450	2.502	-.804	19	.431
	6-week to 6-month	.500	2.305	.970	19	.344
	6-month to 1-year	-.600	2.348	-1.143	19	.267
Relax	Pre to post	-2.00	2.966	-3.090	20	.006
	Post to 6-week	.000	2.720	.000	20	1.00
	6-week to 6-month	-.105	2.401	-.191	18	.851
	6-month to 1-year	-1.000	2.326	-1.824	17	.086
Control	Pre to post	-1.518	3.479	-2.268	26	.032
	Post to 6-week	.666	2.480	1.396	26	.174

6-week to 6-month	-.481	2.764	-.905	26	.374
6-month to 1-year	-.846	2.460	-1.753	25	.092

A significant three-way interaction of time, gender and dog ownership was revealed for children taking part in one-to-one intervention sessions [*F* (4, 208), = 4.337, *p* = .002, η_p^2 =.077] (see Figure 33 below). Post-hoc paired samples t-tests with data split by gender and dog ownership revealed that boys who were dog owners just missed significance between pre- and post-intervention assessments for increase in SC scores. None of the groups across consecutive tests reached significance. Inspection of the mean data indicated that whilst both girls and boys showed increased SC scores immediately after intervention, boys have a dip in SC scores at the 6-week test regardless of dog ownership. Those girls who had a dog at home showed a more consistent pattern of SC scores over the one year study in comparison to boys with a dog at home. None dog owning boys and girls end with similar results at the 1-year test time (see Figure 33 below). Further one-way analyses of variance to assess the differences created by the interaction at the 6-week test time for both groups showed no differences in SC scores between gender based on dog ownership (dog owner (*t* (22) = -.946, *p* = .355), none dog owner (*t* (42) = -1.242, *p* = .221).

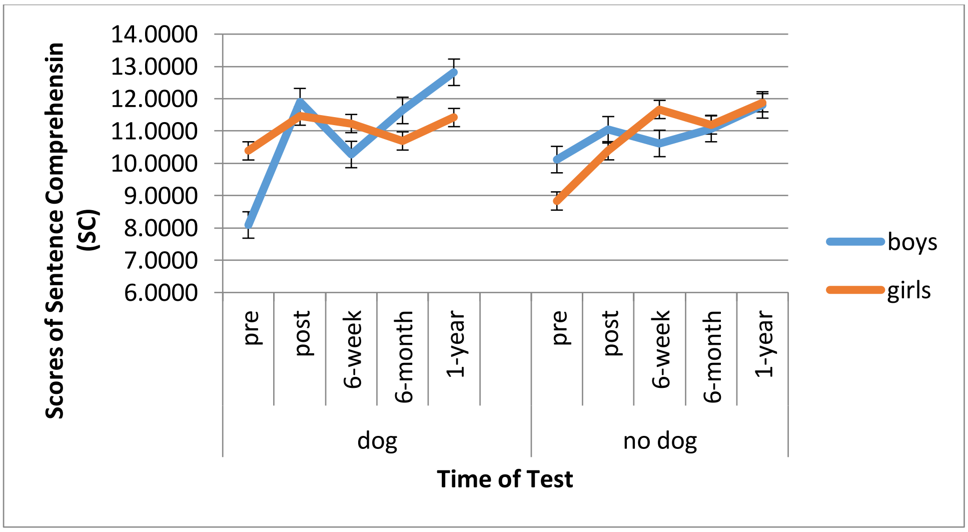

Figure 33. Sentence comprehension (SC), one-to-one -intervention sessions: interaction of time, gender and dog ownership (Bonferroni; *p* = .001)

7.3.1.2 Group sessions: Sentence comprehension (SC)

A significant effect of time was revealed [F (4, 192), = 15.717, p < .001, η_p^2 =.247] with planned comparisons showing that children's sentence comprehension scores only increased significantly immediately after intervention between the pre and post-intervention test times. Scores increased over the length of the study but not significantly between other consecutive test times for children in the group interventions (see Table 62). Once again, a large amount of variance within the model can be accounted for by time.

Table 62
Sentence Comprehension: Group intervention sessions, Planned comparisons for main effect of time (Bonferroni; p = .0125)

Time of test	*M*	*SD*	*t*	*df*	*p*
Pre to post	-1.380	3.138	-3.492	62	.001
Post to 6-week	-.523	3.146	-1.321	62	.191
6-week to 6-month	-.177	2.453	-.570	61	.571
6-month to 1-year	-.606	2.354	-2.012	60	.049

Concerning interactions, and in line with the previous analysis, no main effect for condition [F (2, 48), = 2.441, p =. 098, η_p^2 =.092] or interaction for time with condition [F (8, 192), = 1.420, p =. 190, η_p^2 =.056] were present for children who took part in group interventions. Once again, all conditions showed an improvement in scores over the one-year study; dog (t (17) = -3.945, p = .001), relax (t (17) = -5.807, p < .001), control (t (25) = -3.094, p = .005). Planned comparisons showed that children's SC scores in the dog condition just sat at significance with an increase immediately after intervention (t (18) = -3.324, p = .004) (Bonferroni p = .004). No other consecutive tests across condition showed significant increases in scores for children in group interventions (see Appendix 13). A significant time by dog ownership interaction was found [F (4, 192), = 2.920, p =. 022, η_p^2 =.057]. Moderate variance within the model can be attributed to the interaction. Once adjusted for significance (Bonferroni, *p* = .006) paired samples t-tests with data split by dog ownership failed to reveal any significant differences between both children with and without a dog over consecutive test times. Children's scores increase between baseline and post-intervention assessments, with children who owned a dog showing higher SC scores after intervention. An interaction then occurs whereby those children who were dog owners show a plateau in scores to the 6-month test time, whilst those with no dog at home continue to show improvement to the 1-year test time (see Figure 38). Further one-way analyses of variance to test for differences between SC scores based on dog ownership at the post-intervention, 6-month and 1-year test times, also failed to reveal significant differences in SC scores based on dog ownership (see figure 34 for interaction of dog ownership with time (see Appendix 11).

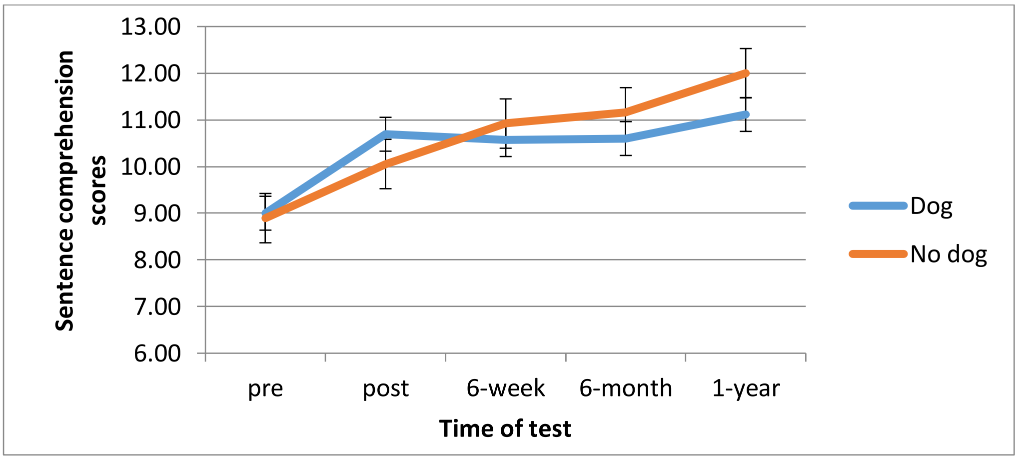

Figure 34. Sentence comprehension (SC) group-intervention sessions: interaction of time and dog ownership (Bonferroni; *p* = .006)

No further main effects or interactions for condition, gender and dog ownership were revealed for children who took part in group intervention sessions.

7.4.1.3 Summary: Sentence comprehension (SC)

Overall, children's sentence comprehension scores increased over the length of the school term, this was evident across all testing and also where data was analysed for one-to-one and group sessions separately. Whilst scores increased over the course of the study, children did not to show significant improvement over all consecutive test times, but as predicted with significant increases occurred between the baseline and post-intervention test times. Time was identified as accounting for a large amount of variance within the model.

No significant interactions for time with condition were identified in the sentence comprehension data but planned comparisons revealed that children who took part in the dog-assisted intervention improved significantly immediately after intervention, whilst those in the relaxation and control conditions did not. This effect was no longer present at the 6-week test time. Once the data was split and analysed based on session-type no significant paired comparisons were found for children's sentence comprehension scores, however, differences were close to significant but only for those in the dog group sessions.

There was no difference in sentence comprehension scores based on children's dog ownership status at the start if the study. An interaction of time with dog ownership was revealed for children who took part in group intervention sessions whereby both those with and without a dog at home made significant improvements in scores between the pre- and post-intervention test times. A plateau in scores after the post-intervention test time is evident for those children who were dog owners. This was in contrast to children without dogs at home, who continued to show improvements in sentence comprehension up to the 1-year test time. Equally, scores at the end of the study were not significantly different based on dog-ownership status.

A three-way interaction of time with condition and gender was present for sentence comprehension scores. Post-hoc analysis failed to identify specific comparisons with significant effects and no differences were found for interactions at specific test times. Overall boys in the relaxation and control conditions showed an improvement immediately after intervention followed by a steady increase to the 1-year test time, whilst boys in the dog condition made improvements up to the 6-month assessment, followed by a slight decline. Girls in the relaxation and control conditions show a steady improvement in scores with both having lower scores at end of the study than boys in the same groups. In contrast, girls who took part in the dog condition show higher scores than boys in the same condition at the end of the study. This interaction was not present for children who took part in group, but not one-to-one intervention sessions.

7.4.2 All children: Syntactic Formulation (SF)

Syntactic formulation comprises a child's ability to construct grammar and use sentences appropriately. The effect of AAI on children's syntactic formulation is firstly reported for all children, followed by separate analysis based on whether the child took part in one-to-one or group intervention sessions. All scores of syntactic formulation increased across the course of the study to the 1-year test time. Whilst scores increase, mean data does showed fluctuations in learning with peaks in scores at the 6-week test time. Gender is equally spread across the conditions apart from the control group which had more boys than girls. Dog ownership was also equally spread across conditions but varied within gender with approximately one third of boys having a dog at home compared to girls who owned a dog. The following tables 63-65 show the results by intervention condition.

Table 63
Syntactic formulation: Mean and standard deviation data for dog intervention, split by gender and dog ownership

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	6	7.833	3.764
		Post-intervention	6	8.000	2.530
		6-week	6	9.500	1.643
		6-month	6	10.16	2.639
		1-year	6	9.667	2.658
	No dog	Pre-intervention	14	7.857	4.016
		Post-intervention	14	8.000	2.828
		6-week	14	8.786	2.424
		6-month	14	7.857	3.060
		1-year	14	8.357	2.649
Female	Dog	Pre-intervention	11	6.909	2.508
		Post-intervention	11	9.364	2.461
		6-week	11	9.091	3.270
		6-month	11	9.091	2.737
		1-year	11	8.182	1.537
	No dog	Pre-intervention	8	7.750	2.121
		Post-intervention	8	9.000	3.071
		6-week	8	9.000	3.117
		6-month	7	9.286	2.215
		1-year	7	9.286	2.628

Table 64
Syntactic formulation: Mean and standard deviation data for relaxation intervention, split by gender and dog ownership

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	8	9.000	2.777
		Post-intervention	8	10.000	2.449
		6-week	8	9.750	2.964
		6-month	7	9.571	1.988
		1-year	8	9.625	2.199
	No dog	Pre-intervention	10	7.500	1.840
		Post-intervention	9	8.888	2.571
		6-week	10	9.600	3.098
		6-month	10	8.300	2.830
		1-year	10	8.500	2.877
Female	Dog	Pre-intervention	9	7.111	1.833
		Post-intervention	9	9.111	2.368
		6-week	9	8.666	3.427
		6-month	9	9.333	2.783
		1-year	8	9.625	2.825
	No dog	Pre-intervention	12	7.416	3.476
		Post-intervention	12	8.500	3.089

		6-week	12	9.583	2.234
		6-month	10	10.200	3.521
		1-year	11	9.909	2.700

Table 65
Syntactic formulation: Mean and standard deviation data for control condition, split by gender and dog ownership

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	4	6.750	1.708
		Post-intervention	4	7.750	0.500
		6-week	4	9.000	2.828
		6-month	4	8.750	3.500
		1-year	4	9.000	0.816
	No dog	Pre-intervention	12	8.333	1.497
		Post-intervention	12	10.083	2.712
		6-week	12	10.417	2.610
		6-month	12	8.583	2.275
		1-year	12	8.833	2.038
Female	Dog	Pre-intervention	4	11.750	3.096
		Post-intervention	4	10.250	2.217
		6-week	4	12.500	4.435
		6-month	4	11.500	1.915
		1-year	4	12.250	2.500
	No dog	Pre-intervention	7	8.429	2.299
		Post-intervention	7	9.571	2.370
		6-week	7	8.571	2.507
		6-month	7	10.429	2.699
		1-year	6	9.167	0.753

A 5 (Time) x 3 (Condition) x 2 (Gender) x 2 (Dog ownership) analysis of variance was conducted to assess the impact of intervention condition on children's syntactic formulation (SF) scores with possible differences for gender and dog ownership taken into consideration. Mauchly's test showed that data met the assumptions of sphericity (χ^2 (9) = 10. p = .293). A significant effect of time was revealed [F (4, 344), = 8.242, p < .001, η_p^2 =.087]; Partial Eta Squared indicates that time represents a moderate degree of variance within the model. Planned comparisons revealed that children's scores increased significantly between the pre and post-intervention time points (t (103) = -5.132, p <.001). No other paired comparisons of SF reached significance (see Table 66 below).

Table 66

Syntactic Formulation, planned comparisons for main effect of time (Bonferroni; p =.0125)

Time of test	*M*	*SD*	*t*	*df*	*p*
Pre to post	-1.105	2.838	-3.973	103	.000
Post to 6-week	-.432	2.679	-1.647	103	.103
6-week to 6-month	.306	2.924	1.055	100	.294
6-month to 1-year	.020	2.329	.086	98	.931

No significant main effect for condition [F (2, 86), = 1.375, p = .258, η_p^2 =.031] or interaction of time with condition [F (8, 344), = .248, p = .981, η_p^2 =.006] were present for children's scores of SF. Comparison of scores within conditions over the year showed that children in the dog (t (37) = -2.068, p = .046) and control (t (25) = -1.743, p = .094), interventions did not improve significantly over the year, whilst those in the relaxation condition did (t (36) = -3.947, p < .001). Interestingly, scores between consecutive tests were investigated further with planned comparisons which demonstrated that none of the groups made a significant improvement in SF between consecutive assessments for any condition. (see Table 67 and Figure 35 below).

Table 67

Syntactic Formulation, planned comparisons for condition over time (Bonferroni; p = .004)

Condition	Time of test	*M*	*SD*	*t*	*df*	*p*
Dog	Pre to post	-1.02	3.256	-1.967	38	.057
	Post to 6-week	-435	2.722	-1.00	38	.324
	6-week to 6-month	.263	3.019	.537	37	.594
	6-month to 1-year	.157	2.635	.369	37	.714
Relaxation	Pre to post	-1.263	2.786	-2.794	37	.008
	Post to 6-week	-.447	2.796	-.986	37	.330
	6-week to 6-month	.194	2.723	.428	35	.671
	6-month to 1-year	-.114	1.966	-3.44	34	.733

Control	Pre to post	-1.00	2.303	-2.255	26	.033
	Post to 6-week	-.407	2.545	-.832	26	.413
	6-week to 6-month	.518	3.142	.857	26	.399
	6-month to 1-year	.000	2.383	.000	25	1.000

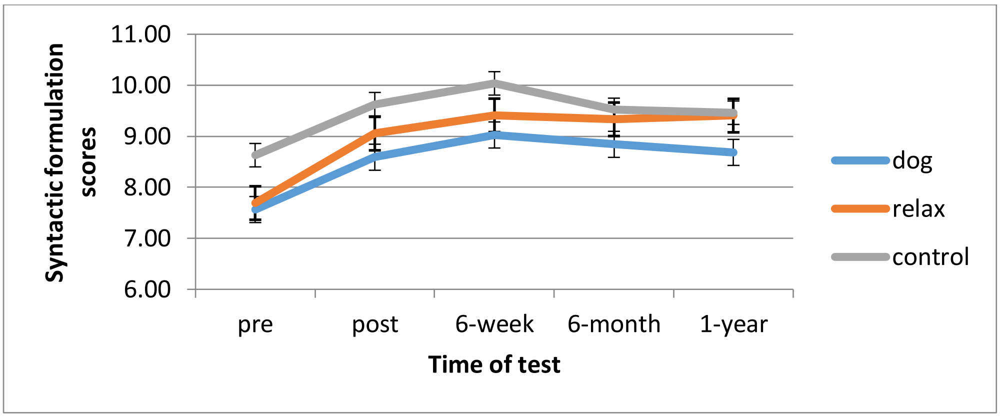

Figure 35. Syntactic formulation scores for condition over time (Bonferroni; p = .004)

No other main effects reached significance and no significant interactions occurred for condition, gender or dog ownership in relation to children's processing of syntactic formulation. The following SF results were analysed separately for session-type, (whether children took part in one-to-one or group intervention sessions).

Two 5 (Time) x 3 (Condition) x 2 (Gender) x 2 (Dog ownership) analyses of variance with repeated measures on the factor of time are conducted. Violation of sphericity was tested and corrections used as appropriate (see Appendix 10).

7.4.2.1 One-to-one sessions: Syntactic formulation (SF)

A significant effect of time was revealed [F (4, 208), = 6.978, $p < .001$, $\eta_p^2 = .118$]. Planned comparisons revealed that children's scores increased significantly between pre and post-intervention time only (t (67) = -4.880, p <.001) (see Table 68).

Table 68
Syntactic Formulation one-to-one sessions: Planned comparisons for main effect of time (Bonferroni; p =.0125)

Time of test	*M*	*SD*	*t*	*df*	*p*
Pre to post	-1.514	2.559	-4.880	67	.000
Post to 6-week	-.352	2.741	-1.063	67	.292
6-week to 6-month	.878	2.989	-2.388	65	.020
6-month to 1-year	-.140	2.315	-0.486	63	.629

In line with the previous analysis no main effect of condition [*F* (2, 52), = 1.294, *p* = .283, η_p^2 =.347] or interaction for time with condition [*F* (8, 208), = .446, *p* = .892, η_p^2 =.017] were present in the one-to-one sessions. Planned comparisons to investigate the effect of interventions on SF showed that only children made significant improvement in scores between the pre- and post-intervention test times. All other planned comparisons failed to reach significance (see Table 94). Over the year, the children in the relaxation condition made the most improvement (*t* (18) = -2.567, *p* = .019) although this just failed to reach significance (Bonferroni; *p* = .016). Those in the dog (*t* (19) = -1.421, *p* = .172) and control (*t* (25) = -1.743, *p* = .094) conditions did not show such improvement (see Table 69).

Table 69
Syntactic Formulation one to one: planned comparisons for condition over time (Bonferroni; p = .004)

Condition	Time of test	*M*	*SD*	*t*	*df*	*p*
Dog	Pre to post	-1.700	3.525	-2.156	19	.044
	Post to 6-week	-.450	3.268	-.616	19	.545
	6-week to 6-month	1.250	2.971	1.88	19	.075
	6-month to 1-year	-.200	2.419	-.370	19	.716
Relaxation	Pre to post	-2.000	1.681	-5.684	20	.000
	Post to 6-week	-.190	2.561	-.341	20	.737
	6-week to 6-month	1.000	2.886	1.510	18	.148

	6-month to 1-year	-.277	2.217	-.541	17	.602
Control	Pre to post	-1.00	2.303	-2.255	26	.033
	Post to 6-week	-.407	2.545	-.832	26	.413
	6-week to 6-month	.518	3.142	.857	26	.399
	6-month to 1-year	.000	2.383	.000	25	1.000

No further main effects or interactions for condition, gender and dog ownership were present within the syntactic formulation data for those children taking part in one-to-one intervention sessions.

7.4.2.2 Group sessions: Syntactic Formulation (SF)

A significant effect of time was found [F (4, 196), = 6.335, $p < .001$, $\eta_p^2 = .113$] showing a significant increase in scores across the 1-year test times, with time accounting for a large proportion of variance within the model. Planned comparisons failed to show significant increases in SF scores between each of the consecutive test times, however further post-hoc paired samples t-tests showed that children's scores increased from baseline to the 6-week, 6-month and 1-year test times (see Table 70).

Table 70
Syntactic Formulation group sessions: planned comparisons for main effect of time (Bonferroni; p = .0125)

Time of test	*M*	*SD*	*t*	*df*	*p*
Pre to post	-.619	2.847	-1.725	62	.089
Post to 6-week	-.507	2.551	-1.580	62	.119
6-week to 6-month	-.209	2.846	-.580	61	.564
6-month to 1-year	.180	2.355	.598	60	.552

In line with the previous analyses, no main effect for condition [F (2, 49), = 61.941, p = .154, ŋ$_p^2$ =.073] or interaction for time with condition [F (8, 196), = 1.055, p = .396, ŋ$_p^2$ =.041] was present for children taking part in the group sessions. Comparisons within condition over the one year study showed that children in the relaxation condition made the most improvement (t (17) = -2.946, p = .009), whilst those in the dog (t (17) = -1.4.74, p = .159) and control conditions failed to show improvements (t (25) = -1.743, p = .094). Planned comparisons failed to reach significance for any condition across all consecutive test times (see Appendix 13).

No further main effects or interactions for condition, gender and dog ownership were present within the syntactic formulation data for those children taking part in one-to-one intervention sessions.

7.4.2.3 Summary: Syntactic formulation (SF)

Children's scores on the tests of syntactic formulation (SF) increased significantly over the course of the study, with significant increases between the pre- and post-intervention. Once data was analysed separately for the type of intervention the children took part in, those in one-to-one sessions still showed significant improvement between the pre-post-intervention tests but those in the group interventions did not. There was no significant main effect for the intervention condition which children took part in, however planned comparisons were run to explore this area further which showed that children who took part in one-to-one relaxation sessions made a significant improvement in SF scores between the pre- and post-intervention test times, again this was not found for those who took part in group interventions. No other main effects or interactions with condition, gender or dog ownership were present within the SF data.

7.4.3 Discussion: Sentence Comprehension and Syntactic Formulation

Overall, children's sentence comprehension scores showed a significant increase with time, specifically between the initial baseline and post intervention test times. This result was consistent regardless of whether the child took part in one-to-one or group sessions with Effect sizes indicated that time accounted for a large amount of variance within the model. As with the results for the BAS scores (previous chapter), a significant increase in sentence comprehension scores over time would be expected, given that the children are attending an educational establishment in which they are actively taught language and grammar on a daily basis. The development of language skills would be expected as part of the child's rapidly developing cognition linked with maturity. As the course of development is not a linear one, the plateau of scores between the 6-week and 6-month testing times is interesting.

Only children who took part in the dog condition showed improved scores between the pre- and post-intervention test times. However, once data was analysed separately based on whether children took part in one-to-one or group intervention sessions, this effect failed to reach significance. Children's performance on the SC tests did not increase significantly based on the intervention condition of dog, relaxation or no treatment control, across any of the other consecutive time points.

A significant interaction of time with dog ownership was found, and interestingly was only present for children who took part in the group intervention sessions. Children without a dog at home showed higher scores overall at the 1-year test time although this continued improvement did not result in a significant difference in SC between dog and none-dog owning children at any of the test times or by the end of the study. Inspection of the mean scores showed that children with a dog at home made more improvement in SC scores to the post-intervention test time than those without a dog, and a cross-over interaction occurred whereby those with a dog showed a plateau in scores up to the 6-month assessment whilst none-dog owning children continued to improve. This interaction accounted for a small amount of variance within the model, with the results presented here suggesting that dog and relaxation interventions do not effect children differently based on dog ownership.

A three-way interaction for time with gender and condition showed that significant differences existed across time in the dog and relaxation conditions but these were not present for children who acted as controls. Girls made more improvement from baseline than boys in both conditions. However, effect sizes were small and further analysis for differences between groups at each test time did not reveal any significant differences between boys and girls relative to the condition which they took part in.

The inspection of a further three-way interaction of time with gender and dog ownership showed that overall patterns of attainment relating to SC scores were very similar for both boys and girls who were dog owners, with the effect size showing that the interaction accounted for only a small amount of variance within the model. This was particularly evident for those children who took part in one-to-one intervention sessions. Whilst an interaction occurred in this cohort as a result of the girls showing increased SC scores beyond those of the boys at the post-intervention test time, the means for children without a dog at home showed more inconsistency. In both the overall, and one-to-one analyses, the girls who did not have a dog at home showed scores increasing beyond those of the boys, however, additional post-hoc analysis looking at data at specific time points showed no significant differences between the SC scores for boys and girls. This three-way interaction was present in the analysis of the one-to-one intervention sessions, but was not present for the children who attended group interventions. It must be noted that the interaction of time with gender and dog ownership accounted for only a small amount of variance within the model.

In line with the sentence comprehension analysis, children's scores for syntactic formulation (SF) increased significantly between the pre- and post-intervention, and although they show an increase over the length of the one year study, scores do not increase significantly between further consecutive test times. This pattern of results was evident for children who had taken part in the one-to-one sessions. Whilst those in the group sessions made improvement in scores overall, they did not significantly improve between any consecutive test tests. Planned comparisons exploring the effects of dog and relaxation interventions on scores of SF also showed differences based on the session type which children took part in. Children in one-to-one relaxation sessions showed significant improvements in SF immediately after intervention, whilst those in the dog condition did not. No effects for intervention condition reached significance for those in the group sessions. Gender and dog ownership both failed to have an effect on children's results.

Significant effects for dog-assisted intervention were different for children's SC and SF scores. Whilst SC scores showed that children who took part in the dog condition showed significantly improved scores immediately after dog intervention, this effect was not visible past the post-intervention assessments, which suggests AAI had a short term effect but a lack of longevity on children's comprehension scores. In contrast, children's SF scores failed to show any effect for the AAI. Given that both language comprehension (SC) and expression (SF) are processed differently, it would therefore seem that the AAI is affecting features of processing within these two language functions differently. Looked at in light of group versus one-to-one sessions only the SC scores showed an effect for AAI in the latter. This may be that group interventions have wider advantages for individuals such as the opportunity for social interaction with peers, identifying as being part of a group with shared interests and rule learning such as turn-taking (Keperling, Reine, Marchese & Ialongo, 2017; Yalom & Leszcz, 2005). Group interventions may also facilitate communication, social skills and greater self-awareness in comparison with others (Yalom & Leszcz, 2005). The lack of an interaction effect within the group scores for SF is therefore surprising.

These results establish clear differences between the development of sentence comprehension and grammar production, and the effect of relaxation and dog interventions. Future studies will need to investigate these differences in more detail. Analysis of the measures related to social, emotional and behavioural outcomes of children taking part in the study, and how intervention with a dog or relaxation may have impacted on these was conducted next.

CHAPTER 8. Effects of AAI on children's social, emotional and behavioural function

8.1 Measures overview for social, emotional and behavioural function

So far research looking at the effect of animal-assisted interventions on socio-emotional and behavioural regulation in school is also sparse. In order to assess the effects of AAI, the current study collected data for social, emotional and behavioural functioning through standardised measures and a further behaviour questionnaire

As greater empathy and social cognition have been linked to relationships with animals, parents were asked to complete the empathy and systemising quotient (EQ-SQ) before the study started and after the interventions had ended at the post-intervention test time. Both empathy and systemising are measured within this tool. The EQ-SQ also highlights gender differences and can be used as a measure of Autistic tendencies (Auyeung et al., 2009) (for details see Chapter 5). Behaviour at home was assessed through a parental questionnaire designed specifically for this project (see Chapter 5). To assess behaviour within the educational environment, classroom behaviour was reported by teachers through completion of the Child Behaviour Rating Scale (CBRS) (for details see Chapter 5). Both the behaviour measures were collected before the study started and immediately after intervention. As self-esteem is often related to behavioural conduct and social cognition, the Culture Free Self-Esteem Inventory (CFSEI-3) was used to assess children's self-esteem (for details see Chapter 5). Children with behavioural difficulties also often exhibit high levels of anxiety therefore the Revised Children's Manifest Anxiety Scale (RCMAS) was also completed. The CFSEI-3 and RCMAS were collected on five occasions at each of the test times by the researcher.

8.1.1 Data management, structure and analysis of social, emotional and behavioural results

Data analysis was first conducted for the parental measures of EQ-SQ and the Home Behaviour questionnaires. Descriptive statistics are presented first for all children followed by an initial one-way analysis of variance (ANOVA) to look for differences between schools. A further analysis was carried out to look at gender differences for the EQ-SQ data. Repeated measures ANOVAs were then conducted separately for scores of EQ and SQ. Not all questionnaires were returned, and frequency data indicated that missing cell values would be a problem for analysis. In order to account for this, measures were assessed using an analysis of time (pre-post) x condition (dog, relaxation, control) x gender (girl, boy), and again to include dog ownership, with time (pre-post) x condition (dog, relaxation, control) x dog ownership (yes, no), with repeated measures on the factor of time for both calculations. Analysis for the parent completed measures of empathising-systemising quotient (EQ-SQ) and Home behaviour questionnaires do not allow analysis of data to be further broken down for one-to-one and group session analysis due to non-returned questionnaires.

Classroom behaviour ratings completed by teachers were analysed next, with descriptive statistics presented for all children followed by an initial one-way analysis of variance to look for differences between schools. This was followed two ANOVAs as above. Analysis was then conducted for session-type of one-to-one and group interventions.

The child reports of self-esteem and anxiety through the Self-esteem inventory (CFSEI) and Revised Manifest Anxiety Scales (RCMAS) were analysed next. A one-way analysis of variance was conducted to look at differences between schools, and was followed by an ANOVA of time (pre-post) x condition (dog, relaxation, control) x gender (girl, boy) x dog owner (yes, no) with repeated measures on the factor of time. Analysis was then repeated for session-type of one-to-one and group interventions.

8.2 Results: Social, emotional and behavioural function

Inspection of the pre-intervention data using the Shapiro Wilk test for each measure is presented below.

EQ-SQ: Pre-intervention data was assessed for violations from normality using the Shapiro-Wilk statistic. EQ data was found to violate the assumptions of normality with skewness of -.700 (SE = .293) and kurtosis of .020 (SE = .578); Shapiro-Wilk W =.952, p = .012. SQ data did not violate normality; skewness = .318 (SE = .293) and kurtosis = .098 (SE = .578); W = .985, p = .593. N = 2 outliers were identified within the data. These are the two boys with a diagnosis of ASD. Once outliers were removed the EQ (W = .966, p = .074) and SQ (W = .982, p = .486) data met the assumptions of normality and so parametric tests are used for analysis of the data.

Home behaviour questionnaires: Pre-intervention data was assessed for violations from normality. Descriptive statistics for skewness -1.221 (SE = .297) and kurtosis 2.044 (SE = .586), Shapiro-Wilk (W =.912, p < .001) show a violation from the assumptions of normality. Due to negative skew, data was reflected and log transformed (Log10); data tends to normality and so parametric tests are employed to analyse the home behaviour scores.

Classroom behaviour questionnaires (CBRS): Pre-intervention data violated the assumptions of normality; skewness -.553 (SE = .236 and kurtosis -.313 (SE = .467), Shapiro-Wilk (W =.907, p < .001) show a violation from the assumptions of normality. Due to negative skew, data was reflected and log transformed (Log10); data tends to normality and so parametric tests are employed to analyse the home behaviour scores.

Self –Esteem Inventory (CFSEI): Pre-intervention data was assessed for violations of normality. CFSEI raw scores were used to assess the number of positive self-esteem items reported by the children before and after intervention. Whilst the Shapiro-Wilk W =.963, p < .005 suggests a violation of the assumptions of normality for the data, scores were found to be only slightly negatively skewed as demonstrated though visual assessment of the histograms with skewness of -.514 (SE = .236 and kurtosis of -.235 (SE = .467). It was therefore decided to use parametric tests for the CFSEI dataset.

Manifest Anxiety (RCMAS): Pre-intervention data was assessed for violations from normality. The Shapiro-Wilk W =.916, $p < .001$ shows a violation from the assumptions of normality for the data, with skewness of -1.122 (SE = .236) and kurtosis 1.806 (SE = .467). Data was log transformed (Log10) with +1 constant to account for zero count scores; data tends to normality, and so parametric tests are employed to analyse the anxiety scores.

8.2.1 All children: Empathy Quotient-Systemising Quotient (EQ-SQ)

Equal numbers of EQ-SQ questionnaires were returned from parents for both girls and boys. Scores are varied across gender, condition and measure of EQ-SQ with no specific pattern evident across mean scores. It is note-worthy that there is high variance across the data and small sample sizes in some cohorts once data is split by gender and dog ownership. Approximately equal numbers of children in the dog and relaxation conditions were dog owners and twice as many children in the control condition had no dog to those who did. Dog ownership was even for girls, whilst twice as many boys did not have a dog compared to those who did. Tables 71 - 73 show the results split by intervention condition.

Table 71

All children, EQ-SQ: Mean and standard deviation data for dog intervention, split by gender and dog ownership

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	EQ-Pre	3	38.666	10.066
		EQ-Post	3	40.333	4.041
		SQ-Pre	3	31.333	7.505
		SQ-Post	3	34.000	8.185
	No dog	EQ-Pre	10	32.700	11.499
		EQ-Post	10	34.500	9.606
		SQ-Pre	10	28.800	7.192
		SQ-Post	10	26.000	5.792

Female	Dog	EQ-Pre	10	40.000	8.602
		EQ-Post	10	39.000	9.649
		SQ-Pre	10	25.200	5.202
		SQ-Post	10	22.500	6.258
	No dog	EQ-Pre	5	37.800	4.919
		EQ-Post	5	38.400	4.505
		SQ-Pre	5	25.200	12.008
		SQ-Post	5	26.600	6.107

Table 72
All children EQ-SQ: Mean and standard deviation data for relaxation intervention, split by gender and dog ownership

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	EQ-Pre	5	33.600	5.319
		EQ-Post	5	30.000	6.041
		SQ-Pre	5	29.600	7.300
		SQ-Post	5	30.400	8.473
	No dog	EQ-Pre	4	39.250	10.307
		EQ-Post	4	41.000	9.416
		SQ-Pre	4	26.000	4.898
		SQ-Post	4	26.750	4.500
Female	Dog	EQ-Pre	3	42.000	4.358
		EQ-Post	3	41.000	1.732
		SQ-Pre	3	25.667	4.932
		SQ-Post	3	26.000	3.605
	No dog	EQ-Pre	8	40.500	4.659
		EQ-Post	8	38.625	6.186
		SQ-Pre	8	23.750	7.573
		SQ-Post	8	22.625	8.016

Table 73
All children EQ-SQ: Mean and standard deviation data for control condition, split by gender and dog ownership

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	EQ-Pre	3	33.666	5.859
		EQ-Post	3	37.333	6.506
		SQ-Pre	3	27.333	8.326
		SQ-Post	3	24.333	8.962
	No dog	EQ-Pre	8	39.375	6.674
		EQ-Post	8	38.100	7.690
		SQ-Pre	8	31.125	8.025
		SQ-Post	8	30.125	5.986
Female	Dog	EQ-Pre	2	46.500	0.707
		EQ-Post	2	48.000	4.242
		SQ-Pre	2	38.000	4.242
		SQ-Post	2	34.000	4.242
	No dog	EQ-Pre	4	42.500	6.137

EQ-Post	4	39.500	5.802
SQ-Pre	4	25.000	9.416
SQ-Post	4	19.000	7.788

An initial one-way analysis of variance was conducted to assess whether data collection of the pre-EQ and SQ scores was different depending on the school the children attended. No significant differences were revealed for school in either EQ (F (3, 64) = 1.435; p = .241) or SQ scores (F (3, 64) = 1.082; p = .364). Data from the different schools is therefore collapsed for analysis.

A further one-way analysis of variance investigated the extent to which the baseline scores reflected the Empathising-Systemising Hypothesis (Baron-Cohen, Knickmeyer & Belmonte, 2005; Auyeung et al., 2009). Accordingly, the results for baseline measures showed a significant difference between boys and girls on the empathising quotient [F (1, 64) = 6.375, p = .014, η_p^2 =.092] with girls scoring significantly higher (M = 40.68) than boys (M = 35.87). Systemising scores also showed a difference based on gender, with boys (M = 28.93) scoring higher than girls (M = 25.65) and this difference failed to reach significance (F (1, 64) = 3.189, p = .079, η_p^2 =.048).

8.2.1.1 All children: Empathy Quotient (EQ)

To assess differences in EQ in relation to intervention condition and gender, a 2 (Pre-Post) x 3 (Condition) x 2 (Gender) analysis of variance was conducted with repeated measures on the factor of time. Children's empathising did not change between the pre- and post-intervention assessments [F (1, 59) = .574, p = .452, η_p^2 =.010]. A significant main effect of gender was found for the scores of EQ [F (1, 59) = 6.037, p = .017, η_p^2 =.093], with girls (M = 40.15) showing significantly higher scores of EQ than boys (M = 36.06). No main effect of condition [F (2, 59) = 1.140, p = .327, η_p^2 =.037] or interaction of time with condition reached significance [F (2, 59) = .991, p = .377, η_p^2 =.033]. In order to assess the effect of interventions, planned comparisons were conducted. These showed that EQ scores were not significantly different between the pre and post-intervention, and that relaxation and dog conditions did not have a significant effect on children's empathising (see Table 74).

Table 74
Empathising Quotient (EQ), planned comparisons for time with condition (Bonferroni; p = .016)

Time	Condition	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Pre-post	Dog	-.571	4.999	-.605	27	.550
Pre-post	Relax	1.450	5.874	1.104	19	.283
Pre-post	Control	.529	4.374	.499	16	.625

To assess the effect of condition and dog ownership on EQ scores, a further 2 (time) x 3 (condition) x 2 (dog ownership) analysis of variance was conducted with repeated measures on the factor of time. No further significant main effects or interactions for condition and dog ownership were revealed within the scores of EQ.

8.2.1.2 All children: Systemising Quotient (SQ)

To assess difference in SQ in relation to intervention condition and gender, a 2 (Pre-Post) x 3 (Condition) x 2 (Gender) analysis of variance was conducted with repeated measures on the factor of time. A significant main effect of time was found for the scores of SQ [F (1, 59) = 6.013, p = .017, η_p^2 =.092], with pre-intervention scores (M = 27.32) being significantly higher than post-intervention scores (M = 26.09). No main effect of condition SQ [F (2, 59) = .361, p = .699, η_p^2 =.012] or interaction of time with condition SQ [F (2, 59) = 2.446, p = .095, η_p^2 =.077] were present. In order to assess the effect of interventions, planned comparisons showed were conducted which revealed that SQ scores were not significantly different between the pre and post-intervention test time, and that the dog and relaxation sessions did not have an effect on children's systemising behaviours (see Table 75).

Table 75
Systemising Quotient (SQ), planned comparisons for time with condition (Bonferroni; p = .016)

Time	Condition	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Pre-post	Dog	1.071	4.760	1.191	27	.244
Pre-post	Relax	.0500	2.818	.079	19	.938
Pre-post	Control	2.882	1.489	1.935	16	.071

No further significant main effects or interactions were revealed within the scores of SQ. To assess the effect of intervention condition and dog ownership on SQ scores, a further 2 (time) x 3 (condition) x 2 (dog ownership) analysis of variance was conducted with repeated measures on the factor of time. As in the previous analysis a significant main effect for time was revealed, however no further main effects or interactions of condition or dog ownership were found for children's measures of systemising.

8.2.1.3 Summary: Empathising Quotient-Systemising Quotient (EQ-SQ)

In order to investigate the effect of dog-assisted interventions on children's measures of empathising and systemising behaviours, the scores for both EQ and SQ were analysed separately. The dog-assisted sessions failed to have an effect on children's empathising and systemising behaviours after four weeks of intervention over the school term. Children in the relaxation and control conditions also failed to show any significant differences between the pre- and post-intervention test times on measures of both EQ and SQ.

Analysis of systemising revealed an effect of time with children having a significant reduction in SQ scores at the post-intervention test time. This was not the case for the EQ scores which failed to show a significant reduction over time. A further main effect of gender demonstrated that girls' scores of empathising were significantly higher than those of boys. The lack of an effect for time indicated that scores were not significantly different after intervention for either gender. Whilst no difference was found for empathising over time, an initial assessment of the baseline EQ and SQ data was consistent with the widely reported findings of a significant difference in scores between boys and girls. This was in line with, and reflected the work of Baron-Cohen, Knickmeyer & Belmonte (2005) and Auyeung et al., (2009) in relation to the Empathising-Systemising Hypothesis; that females show stronger empathizing and males show stronger systemising tendencies. Accordingly, the results showed a significant difference between boys and girls on the baseline measures of the empathising quotient with girls scoring significantly higher than boys.

There were no significant interactions of EQ or SQ with dog ownership status, and no further interactions between time, gender, condition, or dog ownership were revealed. As empathising behaviours are known to link with prosocial behaviour, co-operation and inhibition of aggression, analysis focused next on children's behaviour in the home.

8.3 Results: Children's Behaviour at Home questionnaire

Equal numbers of questionnaires were returned by parents for both boys and girls. Gender across condition was roughly equal apart from the control condition which had twice as many boys questionnaires returned than girls. All groups who took part in the dog intervention show a reduction in scores after intervention. Groups who took part in the relaxation intervention show an increase in scores apart from the boys with no dog at home who show a decline in scores. Both boys and girls who acted as controls, and who did not have a dog at home show an increase in scores, whilst those with a dog showed a decline. Dog ownership was equal across the dog condition however twice as many children in the relaxation intervention had no dog, compared to those that did. Dog ownership for children in the control condition was more unequal with times as many children not owning a dog (see Table 76).

Table 76

Children's behaviour at home scores: Mean and standard deviation data split by intervention condition, gender and dog ownership

Condition	Gender	Dog owner	Time	*N*	*M*	*SD*
Dog	Male	Dog	Pre-intervention	3	64.667	10.116
			Post-intervention	3	63.667	11.930
		No dog	Pre-intervention	10	75.100	5.507
			Post-intervention	10	70.900	5.782
	Female	Dog	Pre-intervention	11	71.000	5.215
			Post-intervention	11	70.182	5.964
		No dog	Pre-intervention	5	71.000	5.050
			Post-intervention	5	70.000	2.550
Relaxation	Male	Dog	Pre-intervention	4	63.750	21.546
			Post-intervention	4	66.000	20.067
		No dog	Pre-intervention	4	58.500	11.210
			Post-intervention	4	55.750	6.292
	Female	Dog	Pre-intervention	2	72.000	2.828
			Post-intervention	2	73.500	0.707
		No dog	Pre-intervention	8	67.500	9.943
			Post-intervention	8	68.625	8.815
Control	Male	Dog	Pre-intervention	2	66.000	16.971
			Post-intervention	2	65.500	7.778
		No dog	Pre-intervention	10	61.800	7.815
			Post-intervention	10	65.500	7.706
	Female	Dog	Pre-intervention	2	73.000	11.314
			Post-intervention	2	71.000	16.971
		No dog	Pre-intervention	4	71.250	5.852
			Post-intervention	4	73.000	6.377

* Note. Higher scores represent better behaviour.

A one-way analysis of variance was then conducted to assess whether data collection of the parental home behaviour questionnaires were different at the beginning of the study depending on the school the children attended. No significant effect of school was returned (F (3, 64) = 1.151, p = .336) showing that parental scores were not significantly different based on school of attendance. A 2 (time) x 3 (condition) x 2 (gender) analysis of variance was carried out to assess the home behaviour questionnaires completed by parents and test the effect of condition and gender on scores. Pre-intervention data meets the assumptions of homogeneity as demonstrated through the Levene's test (F (5, 59) = 1.646, p = .162).

No significant main effect of time was returned [F (1, 59) = 1.940, p = .169, η_p^2 = .032] showing that scores did not change significantly between the parents completing questionnaires at baseline and after intervention. Interestingly, a significant interaction for time and condition was found [F (2, 59) = 4.666, p = .013, η_p^2 = .137] showing a significant change in home behaviour scores after dog intervention only (pre M = 71.56, post M = 69.72); (t (28) = -2.894, p = .007) with children judged to be less well behaved at home after intervention with a dog. In contrast, children's behaviour in the relaxation (pre M = 65.16, post M = 65.72); (t (17) = -.534, p = .601) and control conditions (pre M = 65.61, post M = 67.77); (t (17) = 1.030, p = .318) showed an increase in scores, but these were not significantly different after intervention. Further one-way analyses of variance for pre- [F (2, 64) = 2.897, p = .063, η_p^2 = .085] and post-intervention scores [F (2, 64) = .270, p = .764, η_p^2 = .009] were not significantly different based on condition (see Figure 36).

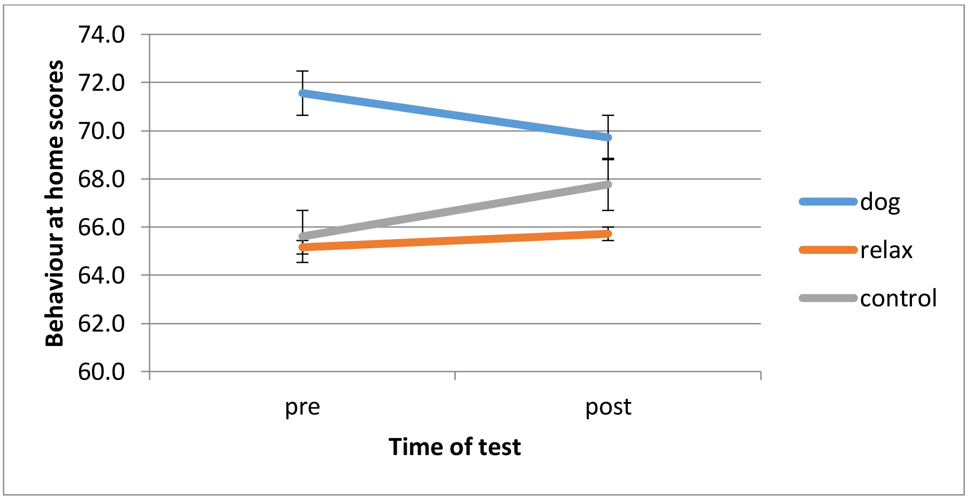

Figure 36. Behaviour at home, planned comparisons for interaction of time with condition

No further main effects or interactions of condition and gender were found. To measure the effects of condition and dog ownership, a further 2 (pre-post) x 3 (condition) x 2 (dog ownership) analysis of variance was carried out on questionnaire scores, but no significant main effects or interactions of dog ownership were revealed. Due to lack of returns for parental data it was not possible to split the data based on session type of one-to-one and group interventions.

8.3.1 Summary: Behaviour at home questionnaires

Children's behaviour at home, as reported by parents, revealed a significant interaction of time with condition, with children who had taken part in the dog interventions showing a decline in behaviour at home after intervention. In contrast, parents of children in the relaxation and control conditions reported a slight increase in behaviour scores, although differences failed to reach significance.

Dog ownership and gender also failed to be significant factors in analysis of home behaviour scores. In order to investigate whether the reports of children's behaviour at home corresponded with that in the classroom (as rated by the class teacher), further analysis was carried to assess this question and assess the impact of dog-assisted intervention on children's behaviour in the classroom.

8.4 Results: Classroom behaviour (CBRS)

Children who acted as controls showed an increase in scores for the teacher rated classroom behaviour scale regardless of dog ownership status. In contrast, boys who took part in the dog intervention showed an increase in scores whilst girls show a decrease; this is regardless of dog ownership status. Differences between groups based on gender and dog ownership can be seen for those who took part in the relaxation intervention, with boys who did not have a dog at home showing a decline in scores and girls who did have a dog also showing a decline. Gender across condition was roughly equal apart from the control condition which had twice as many boys than girls, and dog ownership was equal across the dog and relaxation conditions however two and a half times as many children had no dog in the control condition compared to those who did (see Table 77).

Table 77
Children's behaviour in the classroom scores: Mean and standard deviation split by intervention condition, gender and dog ownership

Condition	Gender	Dog owner	Time	N	M	SD
Dog	Male	Dog	Pre-intervention	6	64.667	9.953
			Post-intervention	6	65.000	6.033
		No dog	Pre-intervention	13	59.077	7.836
			Post-intervention	13	61.000	8.347
	Female	Dog	Pre-intervention	12	68.833	10.530
			Post-intervention	12	67.083	10.908
		No dog	Pre-intervention	8	64.500	9.502
			Post-intervention	8	63.750	8.481
Relaxation	Male	Dog	Pre-intervention	8	65.750	7.778
			Post-intervention	8	66.000	8.586
		No dog	Pre-intervention	10	68.300	7.818
			Post-intervention	10	65.000	8.932
	Female	Dog	Pre-intervention	8	65.125	9.877
			Post-intervention	8	61.625	9.456
		No dog	Pre-intervention	12	65.917	8.404
			Post-intervention	12	67.333	7.377
Control	Male	Dog	Pre-intervention	4	69.500	5.972
			Post-intervention	4	72.250	8.846
		No dog	Pre-intervention	13	60.385	12.087
			Post-intervention	13	63.462	10.604
	Female	Dog	Pre-intervention	4	70.000	8.367
			Post-intervention	4	74.500	5.066
		No dog	Pre-intervention	7	64.857	7.734
			Post-intervention	7	66.429	6.973

**Note; Higher scores represent better behaviour.*

A one-way analysis of variance was conducted to assess whether data collection of the teacher's ratings of child behaviour within the classroom differed significantly between schools. Again, no significant effect of school was returned (F (3, 104) = .407, p = .748) showing that teacher scores for child behaviour within the classroom settings were not significantly different based on school. A 2(time: pre-post) x 3(condition) x 2(gender) analysis of variance was carried out to assess the classroom behaviour questionnaires completed by teachers to test the effect of condition and gender. Pre-intervention scores meet the assumptions of homogeneity as demonstrated through Levene's test (F (11, 93) = .860, p = .582). No main effect if time was revealed [F (1, 99) = .190, p = .664, η_p^2 =.002] but a significant interaction for time and condition was confirmed [F (2, 99) = 3.534, p = .033, η_p^2 =.067] (see Figure 37 below).

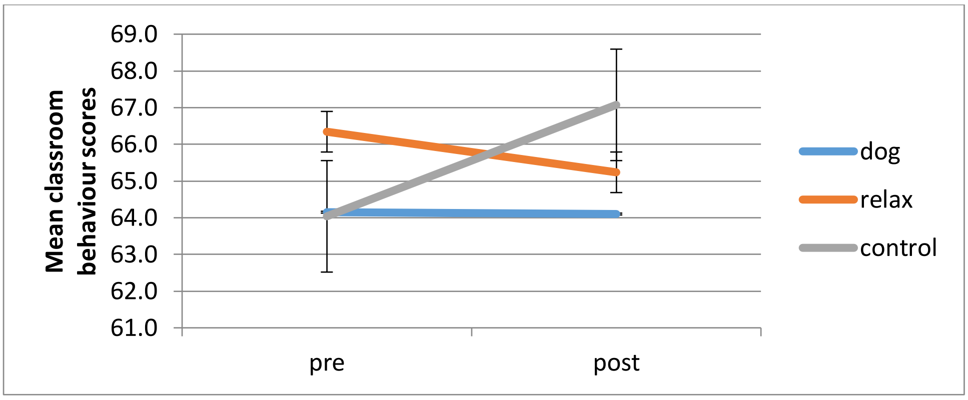

Figure 37. Classroom behaviour, planned comparisons for interaction of time and condition

Planned comparisons revealed a trend for the control group in improved behaviour scores between baseline and post-intervention assessments (see Table 77 below). Observation of the means showed that children who took part in the dog intervention had no change in classroom behaviour after intervention (pre M = 64.15, post M = 64.10), children in the relaxation intervention showed a slight decline in behaviour (pre M = 66.34, post M = 65.23) and in contrast an interaction occurs whereby children in the control condition showed a slight improvement in classroom behaviour without intervention (pre M = 64.03, post M = 67.07) although this did not reach significance. One way analyses of variance to assess data at the pre [F (2, 104) = .051, p = .950, η_p^2 =.001] and post-intervention [F (2, 104) = 2.419, p = .094, η_p^2 =.045] test times showed no difference between conditions at each test time (see Table 78). No further interactions for gender and teacher rated classroom behaviour were revealed.

Table 78

Classroom behaviour: planned comparisons for interaction of time with condition

Condition	Condition	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Pre-post	Dog	-.054	.284	-1.196	38	.239
Pre-post	Relaxation	-.045	.288	-.976	37	.335
Pre-post	Control	.139	.386	1.911	27	.067

Next, a 2 (Pre-Post) x 3(Condition) x 2(Dog ownership) analysis of variance was carried out to assess children's classroom behaviour and the effect of condition and dog ownership on scores. Pre-intervention scores meet the assumptions of homogeneity as demonstrated through Levene's test (F (5, 99) = 1.193, p = .318). A significant main effect for dog ownership [F (1, 99) = 7.326, p = .008, $ŋ_p^2$ =.069] emerged with it accounting for a moderate degree of variance within the model. Mean data showed a difference in teacher scores between children with a dog at home (M = 66.92) who were rated has having better behaviour (self- regulation and social skills) overall than those with no dog at home (M = 63.87). An interaction between condition and dog ownership was also revealed **[**F (2, 99) = 4.236, p = .017, $ŋ_p^2$ =.079] with comparisons showing no significant difference in scores between conditions for children with a dog at home **[**F (2, 41) = 3.051, p = .059, $ŋ_p^2$ =.135]; (dog M = 66.91, relaxation M = 64.62 control M = 71.56), and those with no dog at home **[**F (2, 62) = 1.342, p = .269, $ŋ_p^2$ =.043]; (dog M = 61.59, relaxation M = 66.63, control M = 63.22). Mean data revealed that children in the control condition with a dog at home rated the best behaviour (M = 71.56) and children in the dog condition and who had no-dog at home were rated with the lowest classroom behaviour scores by the teacher (M = 61.59) (see Figure 38 below). No other main effects or interactions with time, condition and dog ownership were present for children's classroom behaviour (CBRS) scores.

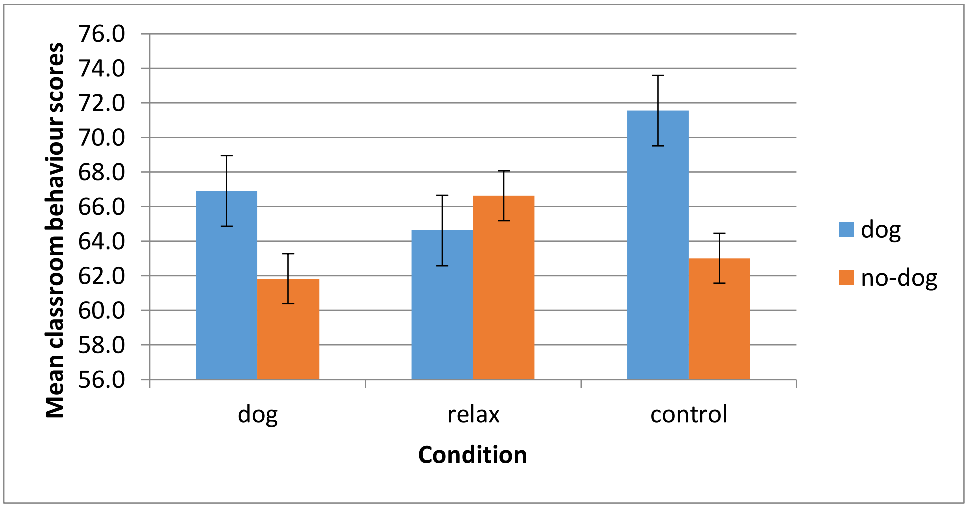

Figure 38. Classroom behaviour, planned comparisons for interaction of condition with dog ownership

The following CBRS results for each of the one-to-one and group intervention sessions will be carried out using a 2 (Time) x 3 (Condition) x 2 (Gender), followed by a 2 (Time) x 3 (Condition) x 2 (Dog ownership) analysis of variance with repeated measures on the factor of time. Violation of homogeneity was tested and corrections used as appropriate (see Appendix 10).

8.4.1 One-to-one intervention sessions: Classroom behaviour (CBRS)

In line with the previous analysis a significant interaction a significant interaction of time with condition was revealed [F (2, 62) = 3.336, p = .042, η_p^2 =.097] for children who took part in one-to-one intervention sessions. Planned comparisons revealed a trend for improved scores for children in the control condition, but no condition reached significance (see Table 79).

Table 79

Classroom behaviour: One-to-one intervention sessions; planned comparisons for interaction of time with condition

Time	Condition	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Pre-post	Dog	-.043	.246	-.780	19	.445
Pre-post	Relaxation	-.085	.250	-1.524	19	.144
Pre-post	Control	.139	.386	1.911	27	.067

No further significant main effects or interactions for condition and gender were revealed in CBRS scores for those taking part in one-to-one intervention sessions.

The further analysis with dog ownership included revealed a significant interaction of time with condition [F (2, 62) = 4.706, p = .013, η_p^2 =.132] with planned comparisons showing no significant differences across conditions. No other significant main effect or interactions of CBRS with dog ownership were revealed for children in the one-to-one intervention sessions.

8.4.2 Group sessions: Classroom behaviour (CBRS)

No significant main effects or interactions of time with condition and gender were present within the classroom behaviour scores for children taking part in the group intervention sessions. In order to investigate the effect of group AAI on children's classroom behaviour, planned comparisons were conducted. Results showed that overall none of the conditions had significant effects on classroom behaviour; dog (t (18) = .890, p = .385), relax (t (17) = -.018, p = .986), control (t (27) = 1.911, p = .067).

The further analysis with dog ownership revealed a significant main effect for condition [F (2, 59) = 3.529, p = .036, η_p^2 =.107] with a large amount of variance within the model accounted for by condition. Observation of the means showed that children in the control condition (M = 65.60) scored higher, and so were rated as having better classroom behaviour than children in the dog (M = 64.63) and relaxation (M = 64.38) conditions.

A further significant main effect of dog ownership was also present for children taking part in group interventions [F (1, 59) = 6.266, p = .015, η_p^2 =.096] with mean data showing that children with a dog at home (M = 67.36) being rated as having better classroom behaviour than those children without a dog (M = 63.39). A further interaction between condition and dog ownership [F (2, 59) = 5.263, p = .008, η_p^2 =.151] was present. Paired comparisons showed a significant difference in scores between conditions for children with a dog at home [F (2, 25) = 5.643, p = .010, η_p^2 =.329]; (dog M = 68.85, relaxation M = 61.31, control M = 71.56), but not for those with no dog at home [F (2, 38) = 1.103, p = .343, η_p^2 =.058]; (dog M = 59.94, relaxation M = 66.85, control M = 63.22) (see Figure 39). Further independent samples t-tests to explore the significant difference of condition for those children who were dog owners did not reveal significant differences between any of the conditions (dog vs relax (t (35) = -.725, p = .473), relax vs control (t (43) = .625, p = .535), dog vs control (t (44) = -.157, p .876).

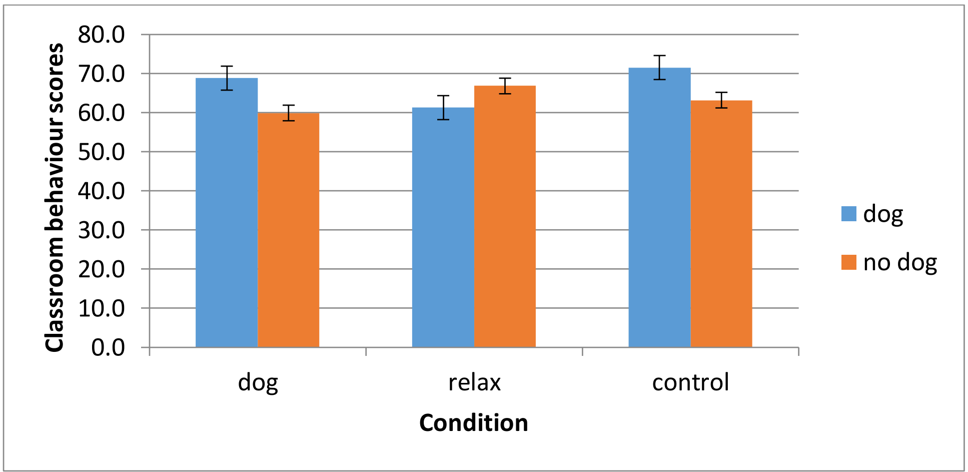

Figure 39. Classroom behaviour, interaction of condition with dog ownership

8.4.3 Summary: Classroom behaviour (CBRS)

A significant interaction of time with condition on classroom behaviour accounted for a moderate amount of variance within the model. Additionally, this interaction was also present in the one-to-one and group intervention data. Whilst planned comparisons failed to reach significance for all conditions, mean data revealed that children who took part in the dog intervention showed no difference in behaviour after intervention, those in the relaxation intervention showed a slight decline, and children in the control condition showed an improvement in classroom behaviour, although this just missed significance. This indicates AAI failed to have an effect on children's classroom behaviour as rated by the class teacher.

A significant main effect for dog ownership showed an overall difference in teacher scores between children with a dog at home, who were rated has having better behaviour, than those children with no dog at home. This effect was found in the data for children taking in group interventions but not for those who took part in the one-to-one sessions. Additionally, an interaction between condition and dog ownership was also revealed. Children in the control condition who had a dog at home were rated as having the best behaviour and children in the dog condition and who had no-dog at home, rated with the lowest classroom behaviour scores. Scores across conditions based on dog ownership were not significantly different when analysis was conducted for all children together. However, once data was split based on session type it was found that children who took part in the group intervention sessions, and who were dog owners showed differences across conditions, whereas children with no dog at home did not.

No significant main effects or interactions with gender were revealed indicating that the teacher rated both boys and girls has having similar behaviour within the classroom. Further assessment was next carried out into the effect of dog-assisted intervention on children's self- reported measures of self-esteem.

8.5 Results: Culture Free Self-Esteem Inventory (CFSEI)

Children's scores of self-esteem increased from the pre-intervention to the 1-year test time, with peaks often occurring in scores at the 6-week and 6-month test times. Gender was roughly equal across the dog and relaxation conditions but more boys are included in the control condition compared to girls. Dog ownership is also equal across the dog and relaxation conditions but was unequal in the control condition with approximately two and a half times more none dog owning children than dog owners. The following tables 80-82 show the CFSEI results by intervention condition.

Table 80

CFSEI scores: Mean and standard deviation data for dog intervention, split by gender and dog ownership

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	6	16.000	2.280
		Post-intervention	6	15.667	2.066
		6-week	6	17.000	2.280
		6-month	6	16.000	2.449
		1-year	6	16.167	1.169
	No dog	Pre-intervention	14	13.000	3.742
		Post-intervention	14	13.571	4.586
		6-week	14	13.571	4.815
		6-month	14	14.214	3.984
		1-year	14	13.286	4.304
Female	Dog	Pre-intervention	11	13.636	3.075
		Post-intervention	11	13.091	3.780
		6-week	11	14.455	2.876
		6-month	11	14.000	3.098
		1-year	11	14.727	3.438
	No dog	Pre-intervention	8	11.625	3.159
		Post-intervention	8	11.750	3.882
		6-week	8	12.375	2.504
		6-month	7	13.429	2.225
		1-year	7	15.143	1.864

Table 81

CFSEI scores: Mean and standard deviation data for relaxation ntervention, split by gender and dog ownership

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	8	12.500	2.878
		Post-intervention	8	12.125	3.523
		6-week	8	13.875	3.137
		6-month	7	12.143	4.451
		1-year	8	14.125	3.314
	No dog	Pre-intervention	10	14.600	2.271
		Post-intervention	9	14.889	3.822
		6-week	10	15.300	3.433
		6-month	10	14.800	3.225
		1-year	10	14.700	3.743
Female	Dog	Pre-intervention	9	10.556	3.812
		Post-intervention	9	10.889	3.371
		6-week	9	11.778	2.728
		6-month	9	11.889	3.140
		1-year	8	13.625	3.292
	No dog	Pre-intervention	12	14.000	3.384
		Post-intervention	12	15.583	3.232
		6-week	12	16.083	2.875

		6-month	10	16.100	3.414
		1-year	11	16.364	3.264

Table 82
CFSEI scores; Mean and standard deviation data for control condition, split by gender and dog ownership

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	4	14.750	2.630
		Post-intervention	4	14.750	2.872
		6-week	4	16.500	3.786
		6-month	4	15.250	3.862
		1-year	4	15.250	4.992
	No dog	Pre-intervention	12	13.917	3.088
		Post-intervention	12	15.167	2.368
		6-week	12	15.667	2.498
		6-month	12	14.750	2.261
		1-year	12	15.917	2.429
Female	Dog	Pre-intervention	4	16.250	0.957
		Post-intervention	4	17.500	1.291
		6-week	4	15.000	2.582
		6-month	4	17.250	1.258
		1-year	4	17.500	0.577
	No dog	Pre-intervention	7	13.429	2.299
		Post-intervention	7	12.714	4.030
		6-week	7	14.857	3.132
		6-month	7	14.000	3.512
		1-year	6	15.167	1.722

An initial one-way analysis of variance was carried out to assess whether self-esteem scores varied significantly depending on the school the children attended [F (3, 104) = .340, p = .796, η_p^2 = .010). Data was therefore collapsed over schools for further analysis. Next, a 5 (Time) x 3 (Condition) x 2 (Gender) x 2 (Dog ownership) analysis of variance was conducted to assess the effect of intervention, gender and dog ownership on children's self-reported measures of self-esteem. Mauchly's test shows that data violates the assumptions of sphericity (χ^2= 9) = 26.377 p < .002), therefore degrees of freedom are corrected using Huynh-Feldt estimates of sphericity. A highly significant main effect of time was revealed for children's measures of self-esteem [F (4.00, 344.00) = 8.448, p < .001, η_p^2 = .089] showing that scores increased significantly over the course of the study. Planned comparisons revealed that scores for self-esteem increased significantly between post-intervention and 6-week test times only, as no other comparisons reached significance (see Table 83).

Table 83
Self-esteem: Planned comparisons for main effect of time (Bonferroni; p = .0125)

Time of test	M	SD	*t*	*df*	Sig (2-tailed)
Pre to Post In	-.346	2.125	-1.660	103	.100
Post- to 6-week	-.778	2.122	-3.743	103	.000
6-week to 6-month	.227	2.097	1.091	100	.278
6-month to 1-year	-.494	2.438	-2.020	98	.046

No main effect of condition [F (2, 86) = 2.470, p = .091, η_p^2 = .054] or interaction of time with condition [F (8.00, 344.00) = .404, p = .918, η_p^2 = .009] were present for scores of self-esteem. Scores for self-esteem between the start of the study and the one year test time showed that children in the dog interventions had the least improvement (t (37) = -1.827, p = .076), followed by those in the relaxation interventions t (36) = -3.404, p = .002) and children in the control condition (t (25) = -3.367, p = .002) had the most improved scores. Planned comparisons were conducted to explore improvements over time within each condition and showed that none of the differences reached significance. Interventions with a dog nd relaxation therefore had no effect on children's scores of self-esteem (see Appendix 14).

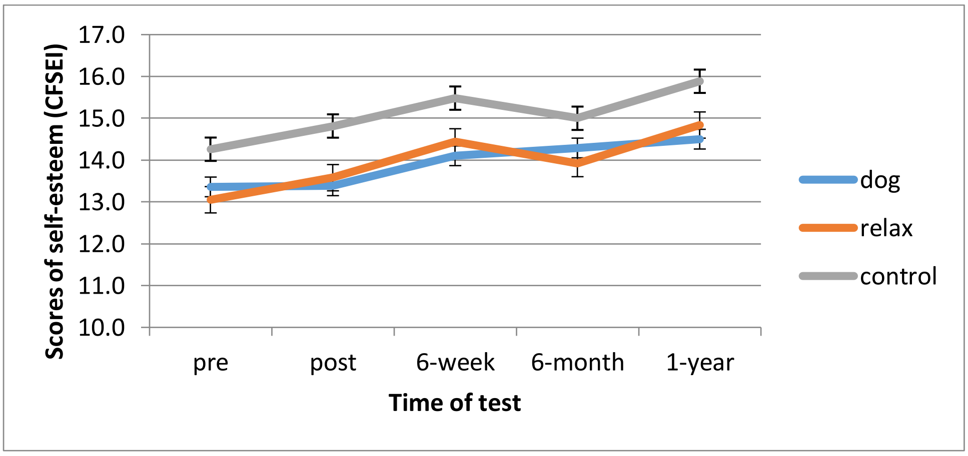

Figure 40. Self-esteem: Condition over consecutive test times (Bonferroni; p = .004)

No other main effects reached significance, but two interactions occurred. A significant interaction for time with gender [F (4.00, 344.00) = 2.447, p = .046, η_p^2 =.028] was revealed with planned comparisons indicating that both girls (t (46) = -4.848, p < .001) and boys (t (53) = -2.066, p = .044) had significantly increased scores of self-esteem between the baseline and 1-year test times. Girls show more improvement over the course of the study than boys creating an interaction with time (see Figure 41 and Table 84 below).

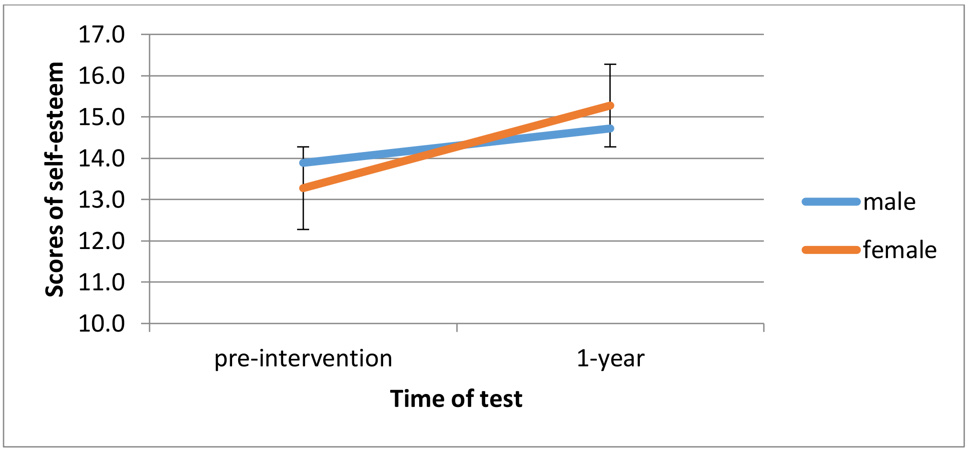

Figure 41. Self-esteem, planned comparisons for interaction of time with gender (Bonferroni; p = .025)

Table 84

Self-esteem: Planned comparisons for interaction of time with gender (Bonferroni; p = .006)

Gender	Time of test	M	SD	*t*	*df*	Sig (2-tailed)
Boys	Pre to Post Intervention	-.358	2.262	-1.154	52	.254
	Post- to 6-week	-.792	1.984	-2.908	52	.005
	6-week to 6-month	.490	2.267	1.575	52	.121
	6-month to 1-year	-.207	2.544	-.594	52	.555
Girls	Pre to Post Intervention	-.333	1.996	-1.192	50	.239
	Post- to 6-week	-.764	2.276	-2.399	50	.020
	6-week to 6-month	-.062	1.872	-.231	47	.818
	6-month to 1-year	-.826	2.293	-2.443	45	.019

An interaction between condition and dog ownership was also present within the data [F (2, 86) = 7.219, *p* = .001, η_p^2 =.144] with no significant differences present between interventions based on dog ownership (see Figure 42 below). Investigation of the mean scores showed that children in the dog (M = 7.08) and control conditions (M = 6.58) who had a dog at home rated higher overall self-esteem than those dog (M = 6.58) and control conditions (M = 6.93) who did not have a dog at home. Children in the relaxation condition showed lower scores if they had a dog at home (M = 6.91), than if they did not have a dog (M = 7.16) (see Table 85).

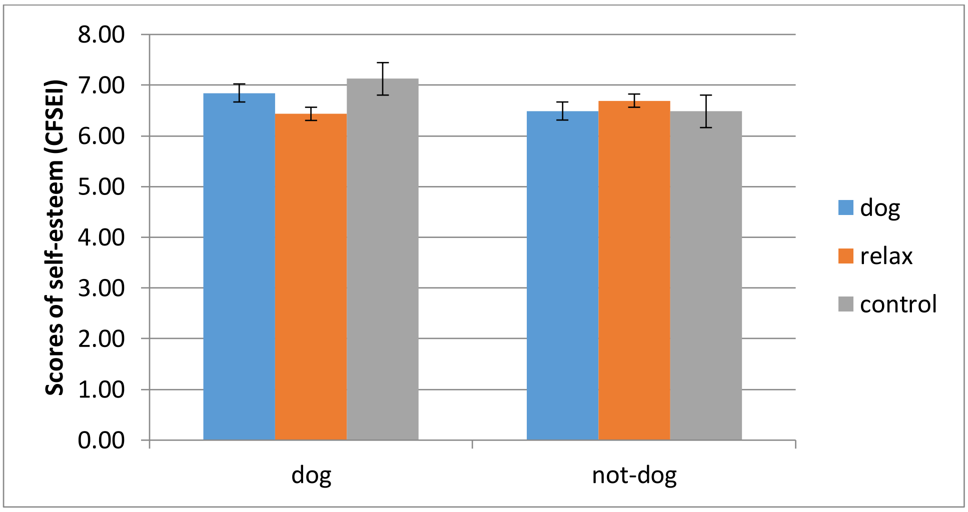

Figure 42. Self-esteem, interaction between condition and dog ownership

Table 85
Self-esteem, planned comparisons for interaction between condition and dog ownership (Bonferroni; p = .008)

Condition comparison	Dog ownership	*t*	*df*	Sig (2-tailed)
Relax-Dog	Dog	1.137	32	.264
	No-Dog	-.478	42	.635
Relax-Control	Dog	-1.393	23	.177
	No-Dog	.586	39	.561
Dog-Control	Dog	-1.027	23	.315
	No-Dog	.017	39	.987

No further significant main effects or interactions were revealed for scores of self-esteem. The following self-esteem results for each of the one-to-one and group intervention sessions will be carried out using a 5 (Time) x 3 (Condition) x 2 (Gender) x 2 (Dog ownership) analysis of variance with repeated measures on the factor of time. Violation of homogeneity was tested and corrections used as appropriate (see Appendix 10).

8.5.1 One-to-one sessions: Self-esteem (CFSEI)

A significant main effect of time was found for self-esteem scores where children took part in one-to-one intervention sessions [F (4.000, 208) = 6.182, p < .001, η_p^2 =.106] with time accounting for a moderate degree of variance within the model. Planned comparisons revealed results in line with the previous analysis whereby although scores increased over the course of the 1-year study, significant increases only occurred between the post-intervention and 6-week test time (see Table 86).

Table 86
*Self-esteem, o*ne-to-one sessions*: planned comparisons for main effect of time (Bonferroni; p = .0125)*

Time of test	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Pre to Post In	-.352	1.937	-1.502	67	.138
Post- to 6-week	-.691	2.001	-2.847	67	.006
6-week to 6-month	.227	2.251	.820	65	.415
6-month to 1-year	-.625	2.503	-1.997	63	.050

No significant main effect of condition [F (2, 52) = 1.315, p = .277, η_p^2 = .048] or interaction of time with condition [F (8, 208) = .537, p = .828, η_p^2 = .020] were present for children in the one-to-one intervention sessions. Scores over the year from baseline showed that children in the dog (t (19) = -1.931, p =.069) and relaxation conditions (t (18) = -2.136, p = .047) had no significant increase in self-esteem, whilst those in the control did (t (25) = -3.367, p = .002). Planned comparisons over time were also in line with the previous analysis confirming that consecutive tests failed to reach significance for all conditions. The one-to-one dog and relaxation interventions failed to have an effect of children's self-esteem (see Figure 43 and Appendix 10).

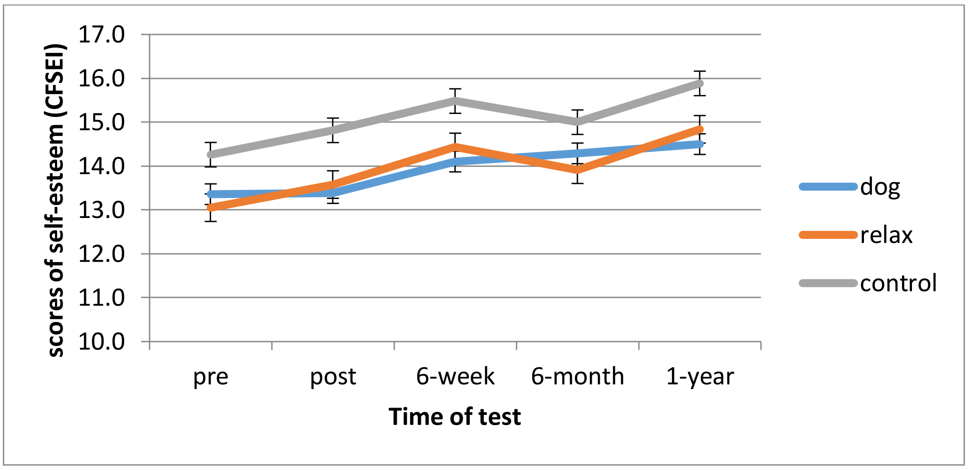

Figure 43. Self-esteem, one-to-one sessions: condition over consecutive test times (Bonferroni; p = .004)

A three-way interaction of time with condition and dog ownership was found for children taking part in one-to-one sessions [F (8.00, 208.00) = 2.209, p = .028, η_p^2 = .078]. Planned comparisons to further investigate this result failed to show significant effects across any of the paired tests of time (see Figure 44). Mean scores revealed that self-esteem increased up to the 6-week assessment but then showed a decline for those in the dog condition with a dog at home and those in the control and relaxation conditions without dog at home, with scores then increasing to the one-year test time. Children in the control condition with a dog at home maintained the highest measures of self-esteem across the one-year study.

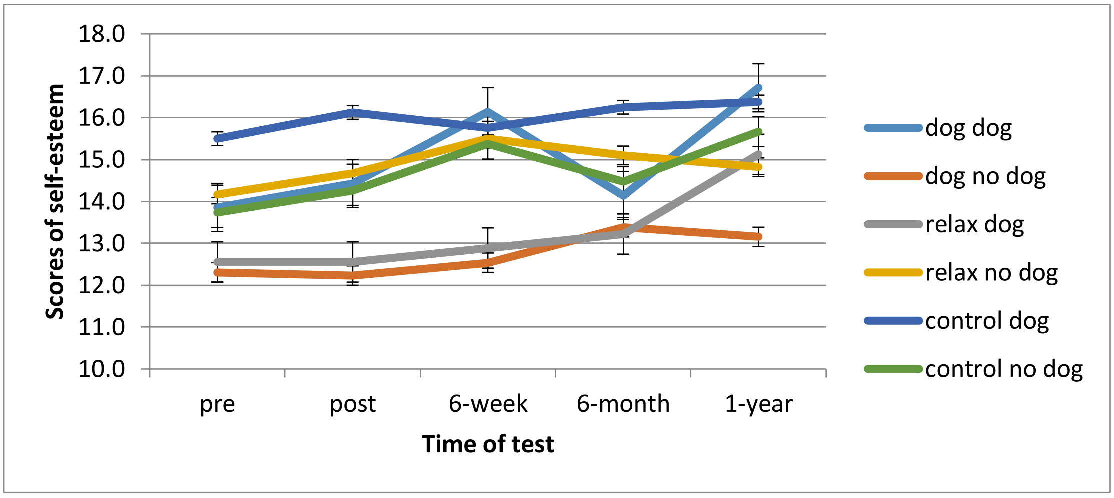

Figure 44. Self-esteem, one-to-one sessions: paired comparisons for interaction of time with condition and dog ownership (Bonferroni; p = .002)

No further main effects or interactions of time with gender and dog ownership were found for children's self-esteem scores when taking part in one-to-one intervention sessions.

8.5.2 Group sessions: Self-esteem (CFSEI)

In line with the previous analysis, a significant effect of time was found for children taking part in group intervention sessions [F (4,192) = 4.076, p = .003, η_p^2 =.078] with planned comparisons also in line with previous tests revealing that children made significant increases in self-esteem scores between the post-intervention and 6-week test time.

A significant main effect of condition which accounted for high amount of variance within the model was investigated [F (2, 48) = 3.344, p = .044, η_p^2 =.122]. None of the comparisons reached significance but overall children in the dog condition (M = 6.72) showed the highest scores of self-esteem, followed by those in the control condition (M = 6.67), and the children in the relaxation condition (M = 6.30) having the lowest scores of self-esteem. Children in the dog and control conditions had more similar scores than those in the relaxation interventions. No interaction was evident for time with condition [F (8.00, 192.00) = .731, p = .664, η_p^2 =.030]. The effect of condition over the length of the study showed that children who acted as controls had the greatest increase in scores of self-esteem (t (25) = -3.367, p = .002), followed by those in the relaxation interventions (t (17) = -2.625, p = .018), and those in the dog intervention showing the smallest increase (t (17) = -.448, p = .660) (see Figure 45). Analysis of scores over consecutive test times confirmed the previous analysis that no within condition differences being found over for children in the group intervention sessions. It can be concluded that dog and relaxation interventions carried out as a group did not have a significant effect on children's self-esteem.

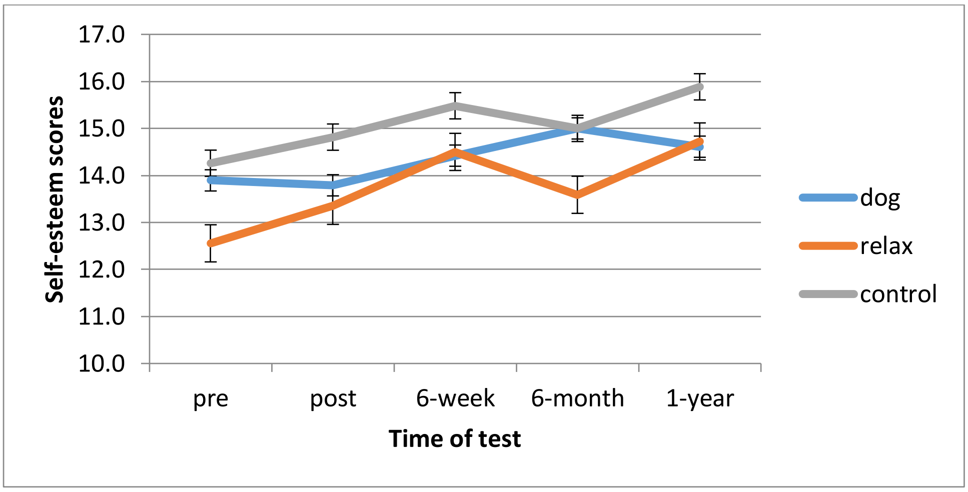

Figure 45. Self-esteem, group sessions: condition over consecutive test times (Bonferroni; *p* = .004)

Self-esteem scores for children in group interventions revealed a significant interaction of time with gender [F (4,192) = 3.398, p = .010, η_p^2 =.066]. Post hoc paired samples t-tests showed that girls who had lower baseline scores, made significant improvements between the pre-intervention and 1-year test times (t (28) = -3.568, p = .001) but boys did not (t (32) = -1.713, p = .096). A further one-way analysis of variance showed that scores of self-esteem at baseline were not significantly different between girls and boys [F (1, 104) = 2.570, p = .112, η_p^2 =.024] (see Figure 46).

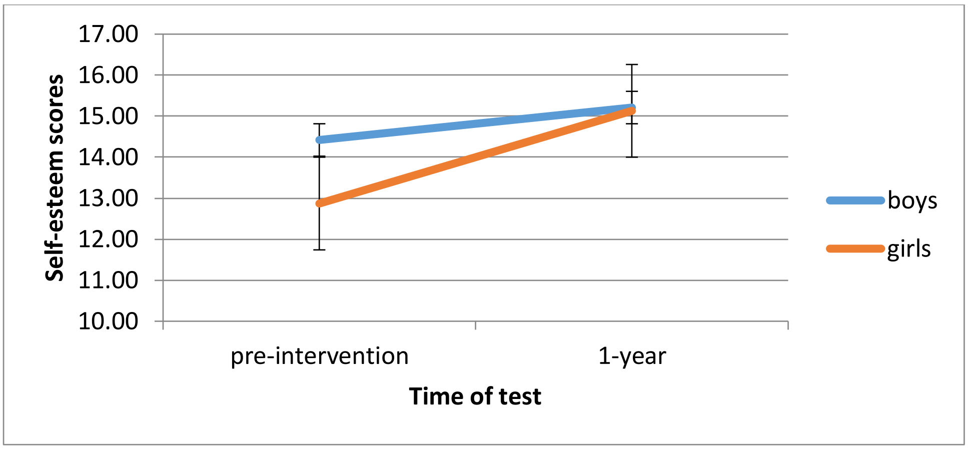

Figure 46. Self-esteem: Group sessions, interaction of time with gender (Bonferroni; p = .025)

A further interaction of condition and dog ownership was revealed for children taking part in the group sessions [F (2, 48) = 7.292, p = .002, η_p^2 =.233], mean data showed that children in the dog (M = 7.06) and control (M = 7.12) conditions who had a dog at home had higher self-esteem than children in the same conditions without a dog at home (dog M = 6.35, control M = 6.48). In contrast children in the relaxation condition had higher self-esteem if they were not dog owners (M = 6.49) compared to those who were dog owners (M = 6.07). Children who were dog owners showed a significant difference in self-esteem scores across condition [F (2, 25) = 4.464, p = .023, η_p^2 =.280] (see Figure 47).

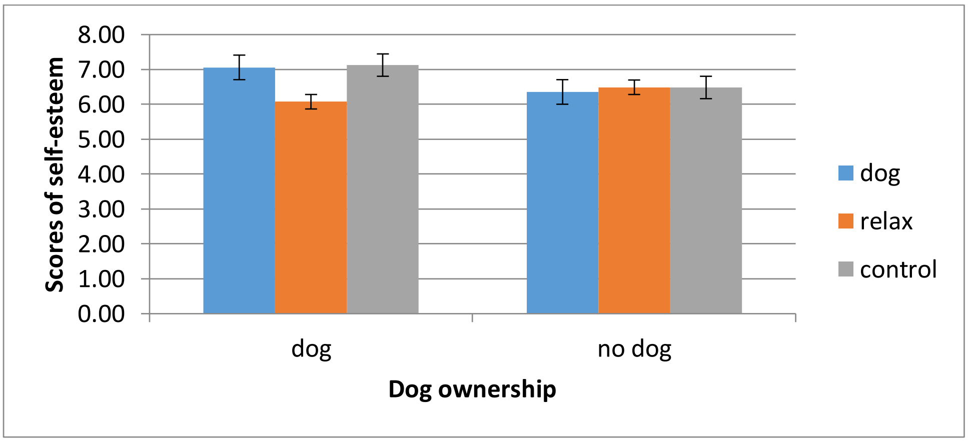

Figure 47. Self-esteem, group sessions: interaction of condition with dog ownership (Bonferroni; p = .008)

8.5.3 Summary: Culture Free Self-esteem Inventory (CFSEI)

Scores of children's self-esteem were collected through the CFSEI and showed a significant effect of time with scores increasing significantly between the post-intervention to six-week test times. This result was consistent across all children and when data was investigated for analysis of one-to-one and group interventions.

No significant interactions for time with intervention condition were present within any of the analyses; planned comparisons did not find significant differences over time based on condition showing that intervention conditions had no effect on children's self-esteem. Time with gender interactions revealed that, as above, all children's scores increased significantly between baseline and 1-year test time, with girls scores showing a greater improvement than those of boys. Data split by intervention condition failed to show such an interaction for children in the one-to-one sessions, however, the result was significant for children who took part in group interventions. Group sessions showed that girls had lower baseline scores of self-esteem but these were not significantly lower than those of boys. Nevertheless, analysis revealed that girls had a significant improvement in self-esteem scores in the group sessions, whilst boys did show significantly improved self-esteem.

Interestingly, an interaction of condition and dog ownership showed that children in the dog and control conditions who had a dog at home rated higher on overall self-esteem than those who did not have a dog at home. Children in the relaxation condition showed a contrasting pattern with overall higher self-esteem in those who did not have a dog at home. Children who had a dog at home showed significant differences in scores across conditions, whereas those with no dog did not. This interaction was present for those who took part in group sessions, but not the one-to-one interventions. A interaction for dog ownership and condition with time for those in the one-to-one sessions demonstrated that there were no differences in self-esteem scores for dog and non-dog owners between conditions.

Observation of the means revealed that children in the control condition who were dog owners maintained the highest scores, whilst those in the dog condition who were not dog owners maintained the lowest scores across the year.

8.6 Results: Revised Children's Manifest Anxiety Scales (RCMAS-2)

Dog ownership and gender showed contrasting anxiety scores for those who took part in the dog interventions with boys who were dog owners and girls without dogs showing decreased anxiety scores over the 1-year study. In contrast boys with no dog and girls with a dog at home showed increased anxiety over the same period. All groups who took part in the relaxation interventions had a reduction in anxiety scores between the baseline and 1-year tests apart from boys who were dog owners showing increased anxiety. Reduction in anxiety scores is also seen for all groups in the control group apart from girls with no dog at home who showed an increase in anxiety scores at the 1-year test time. Dog ownership was equal across girls but twice as many boys had a dog at home than those who did not. There were slightly more none dog owning children, than dog owners in both the dog and relaxation interventions, however dog ownership was unequal cross the children who acted as controls with twice as many children not having a dog at home than those who did. The following tables 87 -89 show the manifest anxiety results by intervention condition.

Table 87
RCMAS scores: Mean and standard deviation data for dog intervention, split by gender and dog ownership

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	6	2.000	1.897
		Post-intervention	6	1.333	1.505
		6-week	6	1.666	2.065
		6-month	6	1.000	1.095
		1-year	6	0.666	1.032
	No dog	Pre-intervention	14	2.571	2.173
		Post-intervention	14	2.714	2.701
		6-week	14	2.857	2.905
		6-month	14	3.071	2.999

		1-year	14	2.928	2.947
Female	Dog	Pre-intervention	11	2.363	1.747
		Post-intervention	11	2.818	2.358
		6-week	11	2.090	1.758
		6-month	11	2.363	2.248
		1-year	11	2.636	1.963
	No dog	Pre-intervention	8	2.125	2.997
		Post-intervention	8	1.250	1.488
		6-week	8	2.125	2.232
		6-month	8	1.125	1.125
		1-year	8	0.625	.517

Table 88
RCMAS scores: Mean and standard deviation data for relaxation intervention, split by gender and dog ownership

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	8	3.000	1.309
		Post-intervention	8	4.250	3.150
		6-week	8	2.000	1.772
		6-month	8	2.375	2.615
		1-year	8	3.625	2.825
	No dog	Pre-intervention	10	2.300	1.251
		Post-intervention	10	1.600	1.505
		6-week	10	1.400	1.173
		6-month	10	1.900	1.791
		1-year	10	1.400	1.897
Female	Dog	Pre-intervention	9	4.333	2.449
		Post-intervention	9	4.000	2.179
		6-week	9	3.111	2.619
		6-month	9	3.888	2.522
		1-year	9	3.333	2.828
	No dog	Pre-intervention	12	2.000	2.088
		Post-intervention	12	1.583	2.574
		6-week	12	1.166	1.642
		6-month	12	1.750	2.416
		1-year	12	1.333	1.669

Table 89
RCMAS scores; Mean and standard deviation data for control condition, split by gender and dog ownership

Gender	Dog owner	Time	*N*	*M*	*SD*
Male	Dog	Pre-intervention	4	2.500	1.914
		Post-intervention	4	2.250	1.258
		6-week	4	1.750	1.500
		6-month	4	1.000	1.154
		1-year	4	1.750	2.217

	No dog	Pre-intervention	12	2.250	1.422
		Post-intervention	12	1.750	1.138
		6-week	12	1.166	1.029
		6-month	12	1.333	1.557
		1-year	12	1.083	1.083
Female	Dog	Pre-intervention	4	2.500	1.290
		Post-intervention	4	1.250	0.957
		6-week	4	1.250	0.957
		6-month	4	1.500	0.577
		1-year	4	0.750	0.500
	No dog	Pre-intervention	7	1.714	2.138
		Post-intervention	7	1.714	1.380
		6-week	7	1.857	1.214
		6-month	7	1.857	1.345
		1-year	7	2.142	1.573

A 5 (Time) x 3 (Condition) x 2 (Gender) x 2 (Dog ownership) analysis of variance was conducted to assess the effect of AAI on children's scores of manifest anxiety. Mauchly's test shows that data violates the assumptions of sphericity (χ^2 (9) 29.108, *p* =.001), therefore degrees of freedom are corrected using Huynh-Feldt estimates. A significant main effect for time was revealed for children's measures of anxiety [*F* (4.00, 344.00) = 6.431, *p* < .001, η_p^2= .070] with scores decreasing significantly between the post-intervention and 6-week test times (Table 90).

Table 90
Anxiety, planned comparisons for main effect of time

Time of tests	*M*	*SD*	*t*	*df*	*p*
Pre to Post Intervention	-0.005	.007	-0.742	103	.460
Post Intervention to 6-week	-0.027	.007	-3.913	103	.000
6-week to 6-month	0.006	.007	0.815	100	.417
6-month to 1-year	-0.014	.008	-1.731	98	.087

No significant effect of condition [*F* (2, 86) = 2.488, *p* = .089, η_p^2= .055] or interaction of condition with time [*F* (8.00, 344.00) = .603, *p* = .776, η_p^2= .014] were present. Planned comparisons revealed that none of the intervention conditions had a significant effect on reducing children's anxiety between each consecutive test time (see Table 91 and Figure 48). Scores calculated from baseline did show that children in the relaxation (t (36) = -3.133, *p* = .003) and the control conditions (t (25) = -2.682, *p* = .013) had significantly decreased anxiety at the 1-year test time, whilst those in the dog condition showed no significant change (t (37) = -1.530, *p* = .134).

Table 91
Anxiety, planned comparisons of time with condition

	Time of tests	*M*	*SD*	*t*	*df*	*p*
Dog	Pre - Post	.007	.081	.610	38	.546
	Post- to 6-week	-.026	.069	-2.408	38	.021
	6-week to 6-month	-.006	.084	-.478	37	.636
	6-month to 1-year	-.003	.097	-.198	37	.844
Relax	Pre - Post	-.014	.064	-1.274	37	.211
	Post- to 6-week	-.032	.074	-2.695	37	.011
	6-week to 6-month	..014	.088	.997	35	.326
	6-month to 1-year	-.024	.086	-1.679	34	.102
Condition	Pre - Post	-.013	.080	-.839	26	.409
	Post- to 6-week	-.021	.073	-1.527	26	.139
	6-week to 6-month	.013	.053	1.327	26	.196
	6-month to 1-year	-.183	.056	-1.638	25	.114

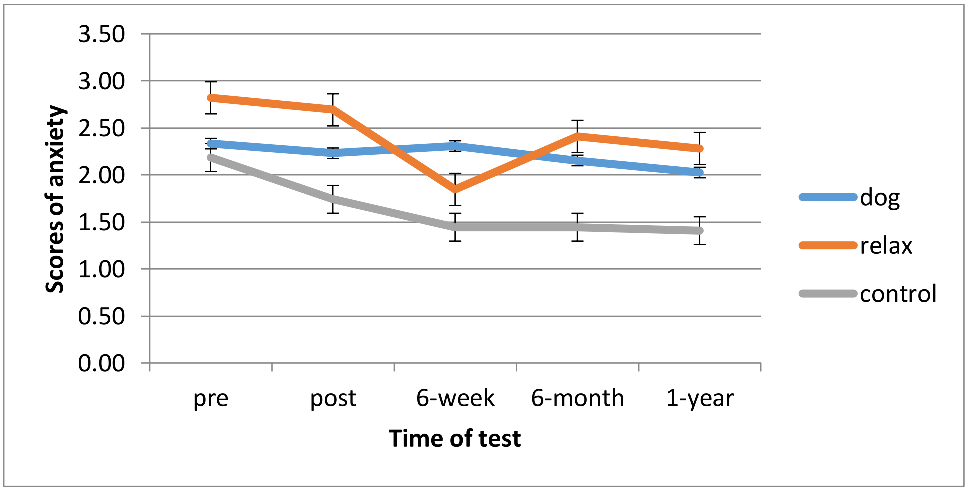

Figure 48. Anxiety scores over time and condition (Bonferroni; p = .004)

A significant interaction between condition and dog ownership [*F* (2, 86) = 6.499, *p* = .002, η_p^2 = .131] was found, with combined factors accounting for a large amount of variance within the model. Post hoc one-way analysis of variance pointed to differences in anxiety scores between children with, and without a dog in the relaxation condition [F (1, 38) = .511, *p* = .004, η_p^2 = .201] whilst scores for those in the dog [F (1, 38) = .095, *p* = .760, η_p^2 = .003] and control conditions [F (1, 26) = .000, *p* = .990, η_p^2 = .000] were not significantly different based on dog ownership status (see Figure 49).

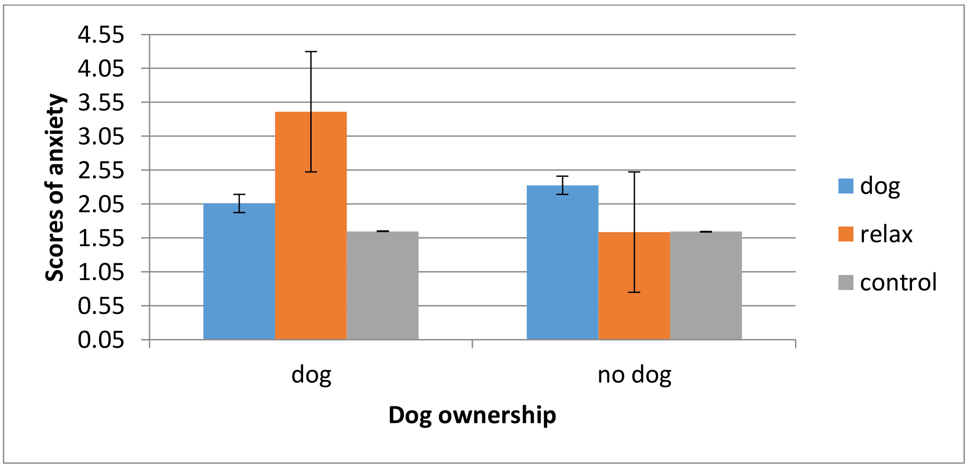

Figure 49. Anxiety, significant interaction between condition and dog ownership (Bonferroni, *p* = .016)

No other significant main effects or interactions were found. The following anxiety results for each of the one-to-one and group intervention sessions will be carried out using a 5 (Time) x 3 (Condition) x 2 (Gender) x 2 (Dog ownership) analysis of variance with repeated measures on the factor of time. Violation of homogeneity was tested and corrections used as appropriate (see Appendix 10).

8.6.1 One-to-one sessions; Manifest Anxiety Scales (RCMAS-2)

In line with the previous analysis a significant main effect of time was revealed [*F* (4.00, 208.00) = 3.847, *p* = .005, η_p^2 = .069] with planned comparisons showing that scores reduced significantly between the post-intervention and 6-week test times.

Table 92
Anxiety, one-to-one sessions: planned comparisons for significant main effect of time (Bonferroni; p = .016)

Time of tests	*M*	*SD*	*t*	*df*	Sig (2-tailed)
Pre to Post Intervention	-0.005	.073	-0.642	67	.523
Post Intervention to 6-week	-0.021	.063	-2.830	67	.006
6-week to 6-month	0.005	.088	.510	65	.612
6-month to 1-year	-0.017	.089	-1.595	63	.116

Once again, no interaction of time with condition was revealed [F (8.00, 208.00) = .382, *p* = .929, η_p^2 = .014], with planned comparisons showing that none of the conditions had a significant effect on anxiety scores over consecutive time points (see Appendix 14). Scores between the baseline and 1-year tests were significantly reduced for those in the control condition only (t (25) = -2.682, *p* = .013), as dog (t (19) = -1.616, *p* = .123) and relaxation conditions (t (18) = -1.880, *p* = .076) failed to reach significance for children in one-to-one intervention sessions. No other main effects of significant interactions were present for children who took part in one-to-one intervention sessions.

8.6.2 Group sessions; Anxiety Scales (RCMAS-2)

Scores of anxiety for children taking part in group interventions decreased significantly over the course of the one year study as demonstrated through a significant main effect of time [F (4.00, 192.00) = 3.928, *p* = .004, η_p^2 = .076]. Planned comparisons showed results consistent with the two previous analyses with anxiety reducing significantly between the post-intervention and 6-week test times only (see Table 93).

Table 93

Anxiety, group sessions: planned comparisons for significant main effect of time (Bonferroni; p = .016)

Time of tests	*M*	*SD*	*t*	*df*	*p*
Pre to Post Intervention	-.008	.081	-.838	62	.405
Post Intervention to 6-week	-.030	.079	-3.085	62	.003
6-week to 6-month	.010	.055	1.475	61	.145
6-month to 1-year	.012	.067	-1.490	60	.141

As with the previous analyses, no significant interaction of time with condition was present for children taking part in group intervention sessions [F (8.00, 192.00) = .982, *p* = .451, η_p^2 = .039]. However, significant reductions in anxiety were revealed for those in the control group over the one year study (*t* (25) = -2.682, *p* = .013), whilst those in the dog (*t* (17) = -.314, *p* = .757) and relaxation conditions (*t* (17) = -2.514, *p* = .022) did not show significant reductions. Planned comparisons were consistent with the results of the one-to-one interventions with conditions over consecutive test times failing to reach significance.

Three further significant main effects were also found for measures of anxiety. Children's scores for anxiety were significantly different between conditions [F (2, 48) = 4.024, *p* = .024, η_p^2 = .144], however whilst there are differences in the mean scores, post hoc analyses failed to reach significance between any of the condition comparisons of dog (M = 2.07) and control (M = 1.64); (*t* (28.513) = .502, *p* = .619), dog and relaxation (M = 2.38); (*t* (35) = -.358, *p* = .722), and relaxation and control (*t* (24.977) = .888, *p* = .383) (see Figure 50 below). Overall children in the control condition had lower scores of anxiety, whilst in the relaxation condition showed the highest scores, with children in the dog condition falling in between the two.

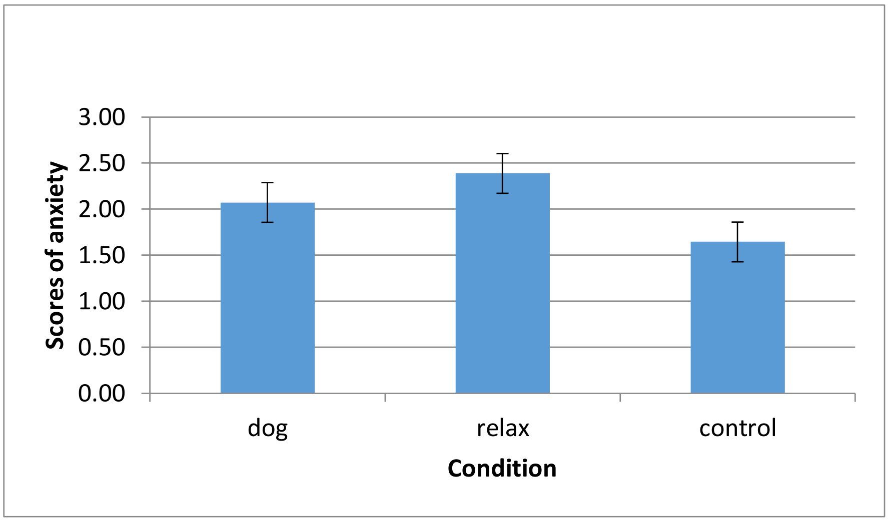

Figure 50. Anxiety, group sessions: significant main effect of condition (Bonferroni; *p= .016)*

A significant main effect for dog ownership was also revealed [F (1, 48) = 4.247, p = .045, η_p^2 = .081], with post hoc tests showing that children who took part in group interventions and who were also dog owners had higher anxiety scores (M = 2.53) than those who did not have a dog at home (M = 1.60). A further significant interaction of time with gender [F (4, 192) = 3.472, p = .009, η_p^2 = .067] revealed that whilst comparison of scores across consecutive time points failed to reach significance, a difference existed for girls between the baseline measure and the 1-year tests with scores decreasing significantly (t (28) = -3.185, p = .004). This result was not evident in the boys scores of anxiety (t (32) =, -1.414, p = .167) (see Figure 51 below).

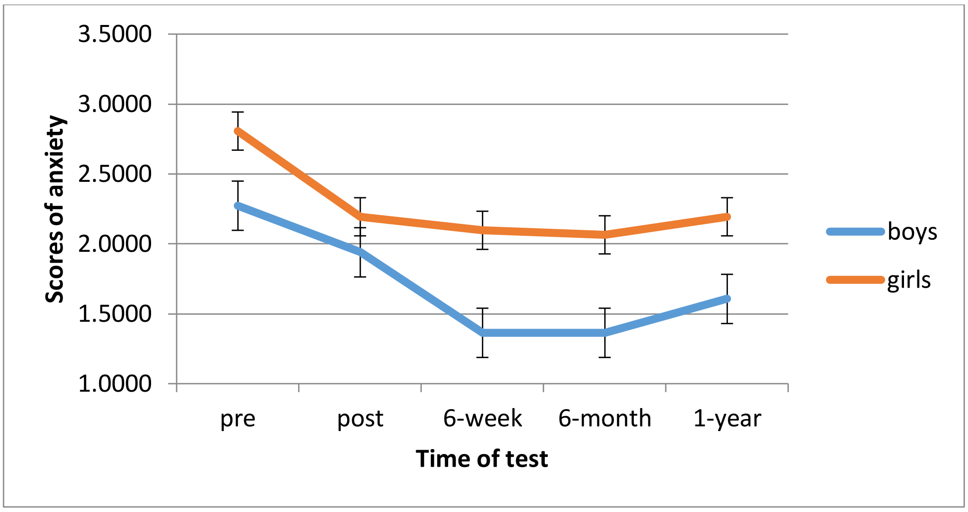

Figure 51. Anxiety, group sessions: significant effect of time with gender (Bonferroni; *p* = .025*)*

A significant interaction between condition with dog ownership was also present in the group intervention data [F (2, 48) = 7.701, *p* = .001, η_p^2 = .243] with post hoc tests revealing that children in the relaxation intervention had significantly higher scores of anxiety if they were dog owners (M = 3.72) than if they were not dog owners (M = 1.32); (*t* (16) = 3.107, *p* =. 007). No such differences existed in the dog condition (dog owners M = 2.28, none dog owners M = 1.84; (*t* (17) = .654, *p* =. 522)) or the control condition (dog owners M = 1.65, none dog owners M = 1.64; (*t* (17) = .654, *p* =. 522) (see Figure 52 below).

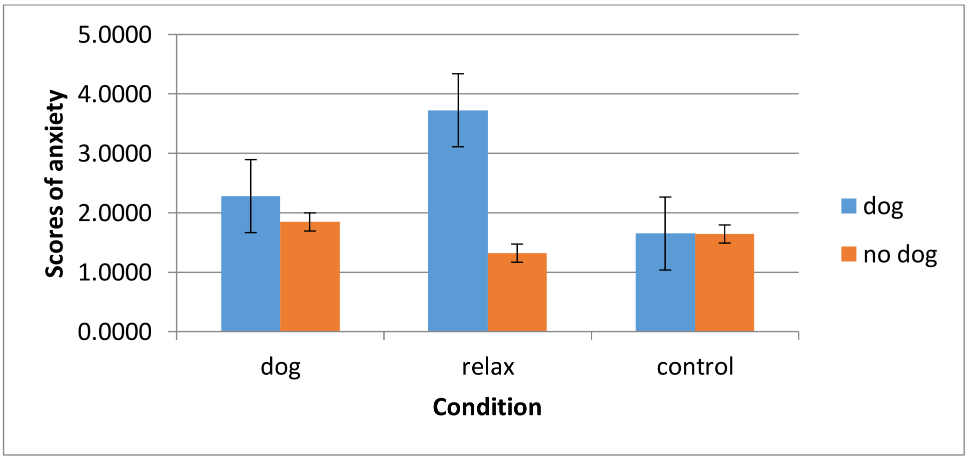

Figure 52. Anxiety, group sessions: significant interaction of condition with dog ownership (Bonferroni; *p* = .016)

Lastly, a three-way interaction of time with condition and gender was revealed [F (8, 192) = 2.076, p = .040, η_p^2 = .080] with post hoc comparisons confirming the results above, whereby girls in the relaxation condition have a significant reduction in anxiety between the baseline and 1-year test times, with this group showing higher scores of anxiety at the pre-intervention assessment. Whilst not significant, an interaction occurs as a result of boys in the control group having reduced anxiety beyond scores of girls at the 6-week test time (see Figure 53 below). No other significant main effects or interactions were present within the anxiety scores for children taking part in the group intervention sessions.

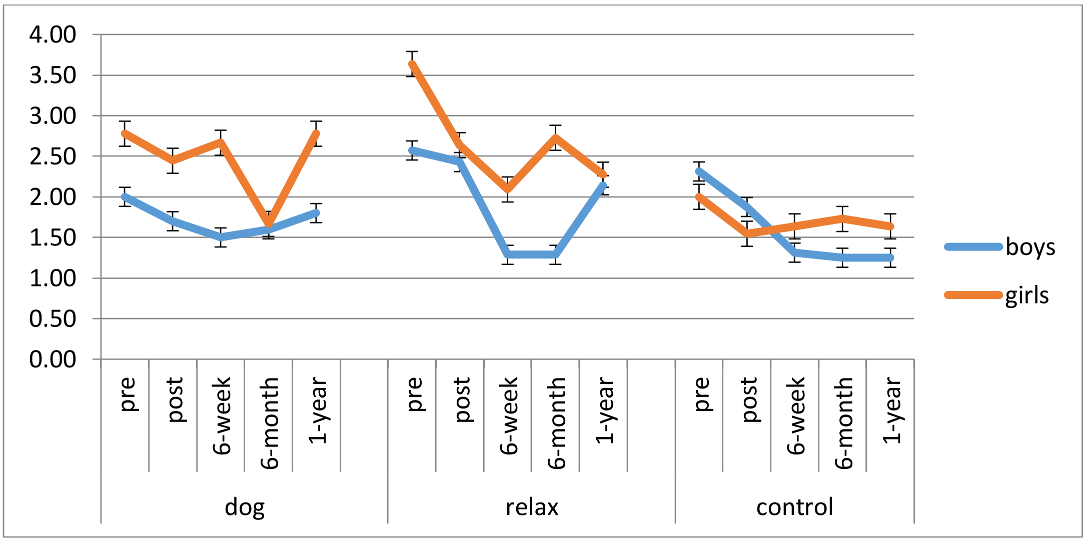

Figure 53. Anxiety, group sessions: significant interaction of time with condition and gender (Bonferroni; p = .002)

8.6.3 Summary: Manifest Anxiety Scales (RCMAS-2)

Children's scores of anxiety as measured through the RCMAS, show a significant decrease over the course of the study. Children's measures of anxiety decreased over the school term but not significantly between all consecutive test times apart from between the post-intervention to six-week test times. This result was consistent across both the one-to-one and group intervention sessions.

No significant interactions for time with condition were present within the anxiety data however planned comparisons unexpectedly revealed that children in the relaxation and control conditions had significant reductions in anxiety scores at the end of the study, whilst those in the dog conditions failed to show any change by the one year test time. Once analysis was conducted for session type separately, children in both the one-to-one and group intervention sessions failed to show significant reductions in anxiety. In contrast, children who acted as controls showed a significant reduction in anxiety over the one year study.

A significant difference in anxiety based on dog ownership status was present for children who took part in the relaxation condition, with those who owned a dog having higher anxiety scores than those children who did not. This result was only evident for children in the group sessions and was not found for children who took part in the one-to-one interventions.

Girls who took part in group interventions had a significant reduction in anxiety over the one year study, whilst boys showed no difference in anxiety scores between the baseline and 1-year test times. A three-way interaction of time with condition and gender also confirmed this result for children in the relaxation condition, in addition an interaction for those in the control condition can be observed as a result of boys anxiety scores reducing at the 6-week test time below the level of the girls anxiety.

With few effects of AAI on children's behaviour, self-esteem and anxiety, a further method for analysing stress is through physiological measures such as cortisol. Further analysis was therefore carried out on measures of children's salivary cortisol.

8.7 Discussion: Social, emotional and behavioural function

Children in the study showed positive improvements in wellbeing measures over the school year, with significant increases in self-esteem and reductions in anxiety. Measures of self-esteem and anxiety were not affected by AAI between consecutive test times but differences emerged overall between the two measures. Scores of anxiety reduced for those in the relaxation and control conditions, whilst children in AAI showed the least improvement. A main effect between conditions suggested differences for measures of self-esteem, however whilst those in the dog group had the highest scores and those in the relaxation sessions had the poorest, differences failed to reach significance between any of the comparisons for dog, relaxation and control conditions. These results do not replicate, and instead, contradict previous research reporting the beneficial effects of AAI on self-esteem and anxiety (Schuck, et al., 2018; Purewal, et al., 2017; Stephanini et al., 2015).

Gender was a significant factor in the scores of both anxiety and self-esteem with girls showing a significant improvement in self-esteem and reduction in anxiety over the school year beyond that of the boys. Girls' scores of anxiety were consistently higher than boys across the year regardless of the significant reduction over time. These higher scores of anxiety for girls also reflect national trends in data (Sadler et al., 2017). Interestingly, significant improvement for girls' self-esteem was only present within the group data and not for those in the one-to-one conditions. This may be a result of beneficial effects of group dynamics although this is unlikely given that both group sessions of relaxation and dog would have involved opposing scenarios of peer interaction, e.g. the dog sessions allowed for interaction between the dog and each other, whilst for the relaxation no interaction occurred whilst children listened to the mediation. Additionally, it is also difficult to assert why this scenario would not have beneficially supported boys self-esteem in the group sessions.

Dog ownership also interacted with condition for both anxiety and self-esteem. No differences between conditions were found for dog ownership apart from in the relaxation condition which showed higher self-esteem and anxiety for those with a dog than, than those with no dog at home who had lower self-esteem. Overall, children in the control condition who were dog owners maintained the highest self-esteem across the study, whilst non-dog owners in the dog condition maintained the lowest.

Parents were also asked to rate their children's behaviour at home. It was found that behaviour was seen to be poorer at home (as reported by parents) after intervention with a dog, whilst no change in scores was reported for children in relaxation and control conditions. These scores do not align with the teacher ratings of classroom behaviour which showed that children with a dog at home were reported as having better classroom behaviour. Previous studies in schools have reported greater classroom cohesion in the presence of a dog (Hergovich et al., 2002; Kotschal & Ortbauer, 2003) but did not measure individual children's behavioural change. The current study therefore adds this dimension to the literature.

The classroom and home behaviour scores showed no differences based on gender, however an effect for dog ownership were present for classroom behaviours. Non-dog owning children were rated as having the poorest behaviour overall, whilst those who lived with a dog were rated as having the best behaviour by the teacher. Children who were dog owners, and who acted as controls had the best class behaviour, whilst those who had no dog at home and were in the dog condition had the poorest classroom behaviour.

Finally, children's measures of empathising (EQ) were consistent with previous literature, with girls having higher overall EQ scores than boys (Auyeung et al., 2009; Baron-Cohen, et al., 2005). Scores of EQ did not change over the school term, and showed no effect of AAI or relaxation. This is surprising given the previous literature suggesting that interactions with pets may have a beneficial effect on children's social and empathising behaviours skills (Schmid, 2011; Hawkins, Williams & SPCA, 2017; Williams, Lawrence & Muldoon, 2010; Melson, 2003; Melson, Peet & Sparks, 1992; Bryant, 1985). It is possible that a four week dog intervention did not provide the quantity or quality of interaction required to foster empathising behaviours seen in the pet ownership literature. In contrast, children's systemising behaviours did reduce significantly by the post-test time however once again this was not affected by intervention condition.

Next, in order to get an objective measure of children's wellbeing directly related to stress, the physiological measure of salivary cortisol was collected and is presented in the following chapter.

CHAPTER 9. Physiological measures: salivary cortisol

9.1 Measures overview for physiological function: salivary cortisol

Physiological measures such as cortisol provide a more objective measure of a child's function than the parent and child questionnaires used above. While any self-report can be influenced by the person filling it in due to social desirability bias, fixed choice, little flexibility and the possibility of misunderstandings, physiological measures are more objective. In addition to eliminating the possibility of bias in reporting of behaviours, cortisol measures are also outside of the conscious awareness of the child. Baseline cortisol represents an overall measure of glucocorticoid functioning directly related to stress. Acute cortisol represents a measure taken immediately before and approximately 30-minutes after intervention, and signifies a response to environmental stressors. This study measured both baseline (at the beginning and end of the school term) and acute cortisol (at sessions, 1, 4 and 8) which allowed for an in depth view of the effects of AAI on children's physiological functioning.

Gender differences in physiological measures, especially in response to stress (Reschke-Hernandez et al., 2017; Zimmer et al., 2003; Kirschbaum, Wust & Hellhammer, 1992) must be taken into account before measures of cortisol are assessed relative to AAI. Additionally, animals and pet ownership have previously been cited as having buffering effects on children's stress responses (Kertes, et al., 2017; Beetz et al., 2012; Tsai, et al., 2010; Nagengast et al., 1997). Importantly, as the study is looking at the effects of AAI, and also given that half of the children in the study had a pet at home, it was crucial to test for potential differences in cortisol at the beginning of the study in order to assess such background differences within the school population being tested.

9.1.1 Data management, structure and analysis of physiological function

The current study collected free cortisol through passive drool saliva samples for both baseline and acute cortisol (for details see chapter 4, sections 4.2.4.1 and 4.2.5.1).. Analysis was divided into baseline and acute measures of salivary cortisol. Descriptive statistics were followed by a one-way analysis of variance (ANOVA) looking at potential differences in collection of samples across schools. Further analysis was then conducted using repeated measures ANOVAs for all children on the effects of time x Condition (dog, relax, control) x Gender (boys/girls) x Dog ownership (dog owner/ none dog owner) with repeated measures on the factor of time. Results are first reported for all children, data was then split based on whether the child took part in one-to-one or group intervention sessions. Planned comparisons and post-hoc analysis were conducted, and adjustments made using Bonferroni corrections to further explore results in more depth.

9.2 Results: Baseline cortisol

Inspection of the pre-intervention data using the Shapiro-Wilk statistic reveals that assumptions of normality for the baseline cortisol measure were violated ($W = .806$, $p < .001$), with skewness of 2.271 ($SE = .254$) and kurtosis of 7.288 ($SE = .503$). Inspection of the pre-intervention acute cortisol data at session 1 (S1), session 4 (S4) and session 8 (S8) also showed violation of the assumptions of normality: S1 ($W = .837$, $p < .001$; skewness of 1.887 ($SE = .347$) and kurtosis of 4.749 ($SE = .681$)), S4 ($W = .874$, $p < .001$; skewness of 1.544 ($SE = .347$) and kurtosis of 3.222 ($SE = .681$)), S8 $W = .650$, $p < .001$; skewness of 3.743($SE = .347$) and kurtosis of 18.994 ($SE = .681$)). Data was log transformed (Log10), tended to normality and parametric tests used to analyse all cortisol measures.

9.2.1 All children; Baseline cortisol, pre-post intervention

Equal numbers of boys and girls gave baseline cortisol samples. Children's measures of baseline cortisol can be seen to increase in all groups between the pre- and post-intervention collections, apart from boys who took part in the dog condition and had a dog at home, and both boys and girls who took part in the relaxation sessions who did not have a dog at home. Across condition and gender equal numbers of children were dog owners, however, whilst dog ownerships was equal across girls, boys were nearly twice as likely to not have a dog at home. Additionally, fewer children were dog owners in the control condition than in the dog and relaxation groups (see Table 94).

Table 94
Baseline c*ortisol: Mean and standard deviation data split by intervention condition, gender and dog ownership*

Condition	Gender	Dog owner	Time	*N*	*M*	*SD*
Dog	Male	Dog	Pre-intervention	7	.1428	.0848
			Post-intervention	7	.1151	.0395
		No dog	Pre-intervention	11	.1008	.0286
			Post-intervention	11	.1122	.0261
	Female	Dog	Pre-intervention	9	.1130	.0415
			Post-intervention	9	.1245	.0346
		No dog	Pre-intervention	7	.1096	.0455
			Post-intervention	7	.1262	.0287
Relaxation	Male	Dog	Pre-intervention	7	.0845	.0391
			Post-intervention	7	.2338	.2030
		No dog	Pre-intervention	11	.1426	.0839
			Post-intervention	11	.1354	.0552
	Female	Dog	Pre-intervention	9	.0991	.0329
			Post-intervention	9	.1761	.0875
		No dog	Pre-intervention	9	.1391	.1079
			Post-intervention	9	.0984	.0499
Control	Male	Dog	Pre-intervention	3	.1065	.0361
			Post-intervention	3	.1055	.0474
		No dog	Pre-intervention	7	.1278	.0256
			Post-intervention	7	.1414	.0363
	Female	Dog	Pre-intervention	3	.0894	.0488
			Post-intervention	3	.1079	.0185
		No dog	Pre-intervention	7	.1047	.0234
			Post-intervention	7	.1610	.0652

A one-way analysis of variance was conducted to assess whether pre-intervention baseline cortisol measures were significantly different at the beginning of the study, based on the school of attendance of the child. No significant effect of school was returned [F (4, 89) = 2.390, p = .057] demonstrating that cortisol was not differentially affected by the school attended. Furthermore, this non-significant effect for school can also be seen as confirmation of highly consistent treatment of salivary cortisol samples collected by the researcher across different school sites, at different time-points over the course of the year-long study.

Further one-way analyses of variance were carried out to assess whether the children's pre-intervention baseline measure of cortisol was significantly different based on dog ownership or gender. No difference was found between the baseline cortisol measures for girls (M = .1120 µg/dL) and boys (M= .1192 µg/dL); [F (1, 89) = .331, p = .567, η_p^2 = .004]. Whilst no baseline cortisol differences are present between boys and girls, it is still important to include gender within further analysis in order to assess possible differences in stress responses to differing interventions. Equally, no difference was found between children who had a dog at home (M = .1075 µg/dL) and those who did not (M = .1216 µg/dL); [F (1, 89) = 1.513, p = .222, η_p^2 = .017]. Again, this will be included within further analysis to assess for possible interactions of AAI with dog ownership status.

To assess the effects of AAI with gender on baseline cortisol measures a 2 (Pre-Post) x 3 (Condition) x 2 (Gender) analysis of variance was conducted with repeated measures on the factor of time. Homogeneity of variance was not violated for the pre-intervention data; Levene's test (F (5, 84) = 1.121, p = .356). A significant main effect of time was revealed [F (1, 84) = 11.368, p = .001, η_p^2 = .119] with time accounting for a large amount of variance within the model. Cortisol measures increased significantly between the baseline (M = .1157 µg/dL) and post-intervention collections after interventions had ended (M = .1377 µg/dL). No further effects or interactions reached significance (see Appendix 15). Interestingly, no main effect of condition [F (2, 84) = .275, p = .760, η_p^2 = .007] or significant interaction of time with condition [F (2, 84) = .825, p = .442, η_p^2 = .019] were found. To inspect the effects of intervention further, planned comparisons were carried out which showed that children in the dog condition exhibited no increase in stress hormone levels from beginning to end of the school term, with no change in cortisol before (M = 114 µg/dL) and after intervention (M = 118 µg/dL) (*t* (33) = -1.272, *p* = .212). In contrast, children in the no treatment control condition showed a significant increase in cortisol (pre M = .110 µg/dL, post M = .137 µg/dL), (*t* (19) = -2.749, *p* = .013). Children in the relaxation condition showed an increase in cortisol (pre M = .119 µg/dL, post M = 155 µg/dL) although this was less strong and failed to reach significance once adjusted (*t* (35) = -2.334, *p* = .025). This demonstrated the moderating effect of dog intervention in children's stress levels over the school term, while those in the no treatment control condition showed a significant increase in stress hormones (see Figure 54 below).

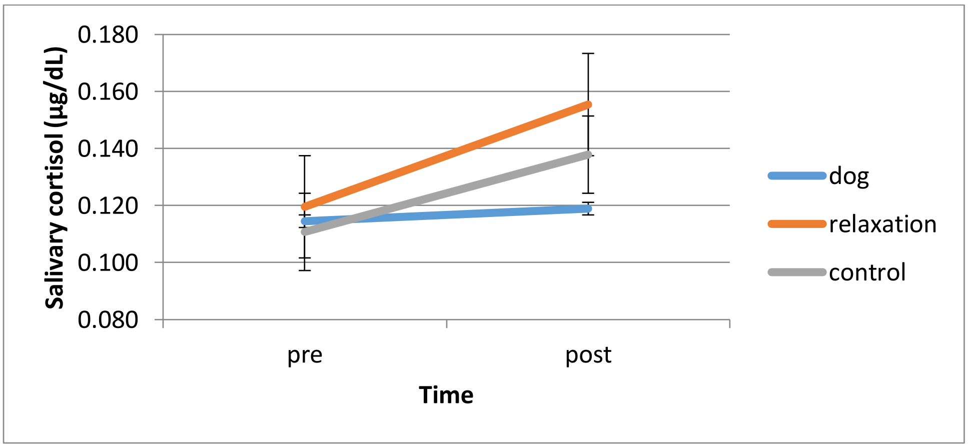

Figure 54. Mean pre-post baseline salivary cortisol for Condition (Bonferroni; *p* = .016)

To investigate potential effects of AAI with dog ownership, a further 2 (pre-post) x 3 (condition) x 2 (dog ownership) analysis of variance was conducted. Again, a highly significant main effect of time was revealed [F (1, 84) = 13.932, p < .001, η_p^2 = .142]. A significant three-way interaction of time with condition and dog ownership [F (2, 84) =

11.307, p < .001, η_p^2 = .212] showed that children in the relaxation condition, who had a dog at home, had a significant increase in cortisol between pre- and post-intervention sessions (t (15) = -4.602, p < .001) (see Table 95). No further main effects or interactions were revealed.

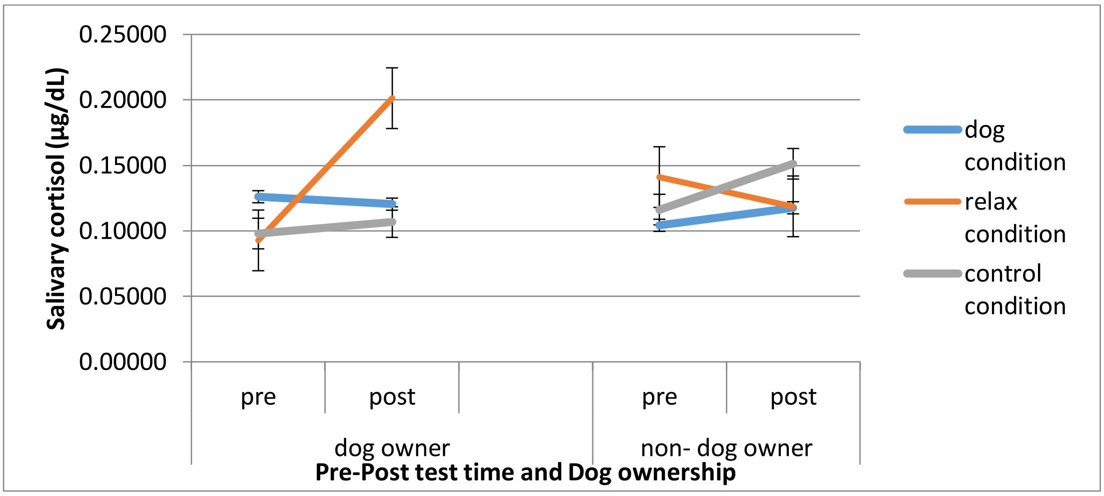

Figure 55. Baseline cortisol: three-way interaction of time, condition and dog ownership,

Table 95

Pre-post-intervention baseline cortisol: Post-hoc paired comparisons for three-way interaction of time with condition and dog ownership (Bonferroni; p = .008)

Condition	Dog Ownership	Time	*M*	*SD*	*t*	*df*	*p*
Dog	Dog	pre post	-.0144	.188	-.324	17	.750
	No-dog	pre post	-.0655	.163	-1.606	15	.129
Relax	Dog	pre post	-.266	.251	-4.244	15	.001
	No-dog	pre post	.0291	.191	.681	19	.504
Control	Dog	pre post	-.0532	.171	-.760	5	.482
	No-dog	pre post	-.1048	.136	-2.868	13	.013

No further main effects or interactions were revealed for baseline cortisol. The following results for baseline cortisol will analyse each of the one-to-one and group intervention sessions using a 2 (Pre-Post) x 3 (Condition) x 2 (Gender) analysis of variance with repeated measures on the factor of time. Due to unequal numbers for dog ownership status across children and lack of cell values for some groups, dog ownership will not be broken down further. Violation of homogeneity was tested and corrections used as appropriate (see Appendix 10).

9.2.2 One-to-one sessions: Baseline cortisol, pre-post intervention

In line with the previous analysis, children in the one-to-one sessions show a significant increase in cortisol over the school term time [F (1, 53) = 9.646, p = .003, η_p^2 = .154] with time accounting for a large amount of variance within the model. No main effect of condition [F (2, 53) = .970, p =. 386, η_p^2 = .035] or interaction of time with condition were returned [F (1, 53) = .384, p = .683, η_p^2 = .014] with planned comparisons also confirming that children in the dog condition did not have an increase in cortisol (t (18) = -1.092, p = .289). In contrast, children in the control condition showed a significant increase (t (19) = -2.749, p = .013), and children in the relaxation conditions showed a less strong increase in cortisol (t (19) = -1.904, p = .072). No other significant main effects or interactions with gender were present for children who took part in one-to-one sessions. No other significant main effects or interactions for intervention were present for baseline cortisol when children took part in one-to-one sessions. As predicted the dog intervention had a beneficial effect on children's stress levels, followed by the relaxation which showed less significant effects, and the no treatment controls showing an increase in baseline cortisol levels.

9.2.3 Group sessions: Baseline cortisol, pre-post intervention

Once again a significant increase in cortisol over the school term was also present for children who took part in group interventions [F (1, 45) = 6.590, p = .014, η_p^2 = .128] with time accounting for a large amount of variance within the model. No main effect of condition [F (2, 45) = .621, p = . 542, η_p^2 = .027] or interaction of time with condition was returned [F (2, 45) = .977, p = . 384, η_p^2 = .042], with planned comparisons confirming that for the group sessions, both children in the dog (t (14) = -.629, p = .539) and relaxation conditions (t (15) = -1.326, p = .205) showed no significant increase in cortisol over the school term, whereas those in the control condition did (t (19) = -2.749, p = .013). No further significant main effects or interactions with gender were present for children who took part in group interventions. Again, this confirms the predictions of the current study.

9.2.4 All children: Acute cortisol at intervention sessions 1, 4 and 8

Children's measures of acute cortisol decreased immediately after intervention. Exceptions were mainly observed for children taking apart in the dog interventions with both girls and boys at session 4 who had a dog at home and girls at session 8, as well as boys who had no dog at home at sessions 4 and 8. All measures of acute cortisol reduced for children in the relaxation condition apart from girls at session 4 who had a dog at home. Dog ownership for boys in the dog intervention was equal, whilst twice as many girls had no dog at home compared to those who were dog owners. Dog ownership across gender in the relaxation condition was equal (see Tables 96 and 97 below).

Table 96
Acute cortisol: Means and Standard deviation for dog intervention by gender and dog ownership

Gender	Dog ownership	Time	*N*	*M*	*SD*
Male	dog	S1pre	5	.12864	.04649
		S1 post	5	.08624	.01242
		S4 pre	5	.16386	.05707
		S4 post	5	.18304	.14867
		S8 pre	5	.08122	.04916
		S8 post	5	.07814	.02057
	No-dog	S1pre	5	.10334	.02615
		S1 post	5	.09524	.01480
		S4 pre	5	.09462	.02365
		S4 post	5	.12358	.05102
		S8 pre	5	.08478	.02596
		S8 post	5	.08974	.04783
Female	dog	S1pre	5	.10334	.02615
		S1 post	5	.09524	.01480
		S4 pre	5	.09462	.02365
		S4 post	5	.12358	.05102
		S8 pre	5	.08478	.02596
		S8 post	5	.08974	.04783
	No-dog	S1pre	9	.14443	.08890
		S1 post	9	.12863	.10571
		S4 pre	9	.14342	.04478
		S4 post	9	.09147	.03793
		S8 pre	9	.12182	.05112
		S8 post	9	.10171	.03686

Table 97
Acute cortisol: Means and Standard deviation for relaxation intervention by gender and dog ownership

Gender	Dog ownership	Time	*N*	*M*	*SD*
Male	dog	S1pre	4	.09098	.04502
		S1 post	4	.06693	.03074
		S4 pre	4	.16018	.13618
		S4 post	4	.08900	.01130
		S8 pre	4	.12935	.07578
		S8 post	4	.12363	.05658
	No-dog	S1pre	8	.10984	.05315
		S1 post	8	.07780	.04523
		S4 pre	8	.14761	.07096
		S4 post	8	.08436	.02295
		S8 pre	8	.15135	.05727
		S8 post	8	.08771	.03902

Female	dog	S1pre	4	.13605	.07944
		S1 post	4	.11818	.01782
		S4 pre	4	.15763	.05696
		S4 post	4	.18385	.10609
		S8 pre	4	.21353	.25840
		S8 post	4	.10888	.05626
	No-dog	S1pre	7	.14441	.06526
		S1 post	7	.13353	.07239
		S4 pre	7	.12219	.03271
		S4 post	7	.09381	.05507
		S8 pre	7	.13054	.04837
		S8 post	7	.08079	.02535

9.3 Results: Acute cortisol at sessions 1, 4 & 8

Since not all children gave saliva for acute cortisol at every time point over interventions S1, S4 & S8 intervention sessions, data is analysed separately for each of the intervention time points allowing all children's data to be included within analysis. Further analysis looking at patterns in acute cortisol over the school term is then conducted.

9.3.1 Intervention session 1 (S1)

Complete samples for session1 were obtained for N = 63 children. Pre-intervention samples were examined for normal distribution; skewness = 1.614 (SE = .302), kurtosis = 2.371 (SE = .595), Shapiro-Wilk (W = .833, p< .001) demonstrating that data violated the assumptions of normality. Data was log transformed (Log10) distribution tends to normality; skewness = .518 (SE = .302), kurtosis = .159 (SE = .595), Shapiro-Wilk (W = .969, p = .107) and parametric tests used for the analysis of S1 acute cortisol samples.

Table 98
Means and Standard Deviations for the measure of Children's Acute Cortisol at session 1 and as a result of Intervention Condition

		Pre-intervention		Post intervention	
Condition	*N*	*M*	*SD*	*M*	*SD*
S1 All children	63	.133	.068	.101	.055
S1 Dog	30	.138	.067	.102	.062
S1 Relaxation	33	.127	.070	.099	.049

A 2 (Pre-Post) x 2 (Condition) x 2 (Gender) analysis of variance was conducted to assess S1 acute data. Levene's test demonstrated that equality of variance was not violated for either measures; pre (F (3) = 1.922, p = .136), post (F (3) = 2.427, p = .074) sessions. A significant main effect for time (pre-post) on acute cortisol measures was confirmed [F (1, 59) = 15.905; p < 0.001, η_p^2 = .212] with S1 acute cortisol measures being significantly higher before (M = .1330 µg/dL) than after intervention (M = .1012 µg/dL). No main effect of condition was revealed [F (1, 59) = .472; p = .495, η_p^2 = .008] and no interaction of time with condition was present either [F (1, 59) = .166; p =.685, η_p^2 = .003]. Planned comparisons showed that children in both the dog (t (29) = 3.727, p = .001) and relaxation (t (32) = 2.353, p = .025) interventions had a reduction in acute cortisol at S1.

A significant main effect between gender was present [F (1, 59) = 4.927; p = .030, η_p^2 = .077] and accounted for a moderate degree of variance within the model. One-way analysis of variance revealed that there was a significant difference between boys' (M = .112 µg/dL) and girls' (M = .152 µg/dL) cortisol in the S1 pre-intervention samples (F (1, 62) = 5.510, p = .022), however, this difference was no longer in existence after intervention (F (1, 62) = 2.186, p = .144), with girls' cortisol (M = 112 µg/dL) showing somewhat greater reduction (t (32) = 3.075, p = .004) after intervention than boys' cortisol (M = .088 µg/dL) (t (29) = 2.745, p = .010), however, both are significant (see Figure 56).

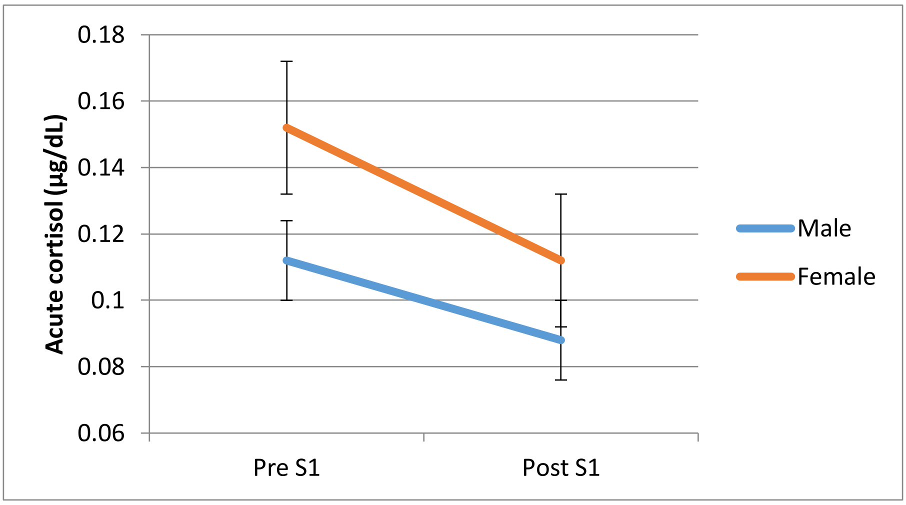

Figure 56. Mean *pre-post-acute cortisol at session 1*

To look at the effect of dog ownership in S1 acute cortisol, a 2 (time: pre-post) x 2 (condition) x 2 (dog ownership) analysis of variance was conducted. As with the previous analysis a significant time (pre-post) effect was confirmed [F (1, 59) = 15.728; p < 0.001, η_p^2 = .210] with S1 acute cortisol measures being significantly higher (M = .1330 µg/dL) than cortisol after intervention (M = .1012 µg/dL). No significant main effect for dog ownership, or interactions were revealed within the S1 acute cortisol data. No significant main effect for dog ownership, or interactions were revealed within the S1 acute cortisol data.

9.3.2 Intervention session 4 (S4)

Complete samples for session 4 were obtained for N = 67 children. Pre-intervention samples were examined for normal distribution; skewness = 1.089 (SE = .293), kurtosis = 2.101 (SE = .578), Shapiro-Wilk (W = .936, p = .002) demonstrating that data violated the assumptions of normality. Data tends to normality after transformation (Log10); skewness = -.978 (SE = .293), kurtosis = 2.940 (SE = .578), Shapiro-Wilk (W = .937, p = .002). Parametric tests will therefore be used for the analysis of S4 acute cortisol samples.

Table 99

Means and Standard Deviations for the measure of Children's Acute Cortisol at session 4, as a result of Intervention Condition

		Pre-intervention		Post intervention	
Condition	*N*	*M*	*SD*	*M*	*SD*
S4 All children	67	.134	.061	.106	.063
S4 Dog	32	.125	.047	.111	.073
S4 Relaxation	35	.142	.071	.101	.053

A 2 (Pre-Post) x 2 (Condition) x 2 (Gender) analysis of variance was conducted to assess S4 acute data. Levene's test demonstrated that equality of variance was not violated for pre (F (3) = 1.431, p = .242) or post data (F (3) = 2.340, p = .082) sessions. A significant main effect for pre-post measures was confirmed (F (1, 63) 16.425, p < .001, η_p^2 = .207) with pre-intervention S4 cortisol (M = .134 µg/dL) being significantly higher than post-intervention S4 cortisol (M = .106 µg/dL). No main effect of condition [F (1, 63) = .034; p =. 854, η_p^2 = .001] or interaction of condition with time was present [F (1, 63) = 1.667; p =. 201, η_p^2 = .026]. Planned comparison to assess the effects of interventions revealed that children's cortisol showed no change after dog intervention (t (31) = 1.815, p < .079) but a significant reduction after relaxation intervention at S4 (t (34) = 4.064, p < .001). A three-way interaction of pre-post x condition x gender was revealed [F (1, 63) = 8.188; p =. 006, η_p^2 = .115]. Post-hoc paired t-tests with data split by condition and gender showed that girls in the dog condition had a significant reduction in cortisol after intervention at S4 (t (16), 4.014, p = .001) with those in relaxation sessions missing significance (t (16) = 1.993, p = .064). Boys in the relaxation condition show a significant reduction in cortisol after intervention at S4 (t (17) = 3.772, p = .002). Unexpectedly, boys in the dog condition show an insignificant increase in cortisol after intervention (t (14) = -.548, p = .593) (see Figure 57).

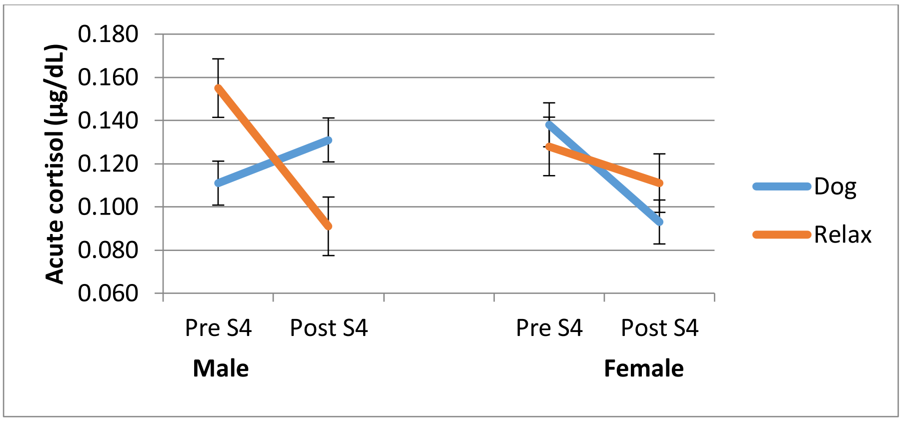

Figure 57. Mean *pre-post-acute cortisol at session 4 for Condition and Gender*

A further 2 (Pre-Post) x 2 (Condition) x 2 (Dog ownership) analysis of variance was conducted to assess the effect of dog ownership on children's S4 acute cortisol measures. As with the previous analysis, a significant effect was found [F (1, 63) = 12.385; p =. 001, η_p^2 = .164] with cortisol being significantly lower after intervention (M = .106 µg/dL), than before (M = .134 µg/dL). No significant main effect of condition [F (1, 63) = .000; p =. 990, η_p^2 = .000] or interaction of time with condition [F (1, 63) = .317; p =. 575, η_p^2 = .164] were found. Planned comparisons were conducted and revealed that children in the dog condition (t (31) = 1.815, p = .005) did not show a significant difference in cortisol after intervention at session 4. In contrast, children who attended the relaxation sessions (t (34) = 4.064, p < .001) showed a significant increase in cortisol after intervention at session 4.

A significant three-way interaction for pre-post cortisol, condition and dog ownership was present within the S4 data [F (1, 63) = 5.201; p =. 026, η_p^2 = .076]. A paired samples t-test with data split by condition and dog ownership shows that children in the relaxation condition with no dog at home demonstrated a significant reduction in cortisol after intervention at the S4 time point (see Table 100 and Figure 58 below).

Table 100

S4, post-hoc paired comparisons for three-way interaction of pre-post, condition and dog ownership

Condition	Dog ownership	*t*	*df*	*p*
Dog	Dog	1.454	14	.168
	No-dog	1.069	16	.301
Relax	Dog	.687	11	.706
	No-dog	5.109	22	.000

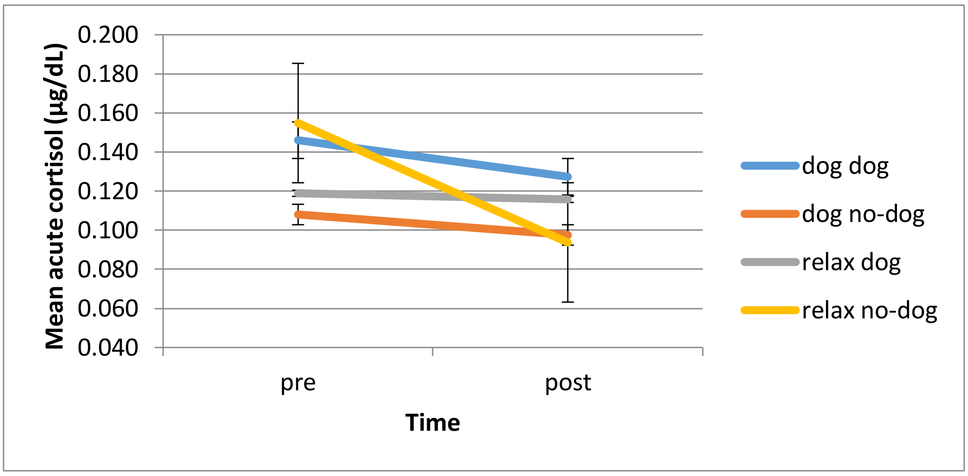

Figure 58. S4 interaction for time, condition and dog ownership

9.3.3 Intervention session (S8)

Complete samples for session 8 were obtained for N = 70 children. Pre-intervention samples were examined for normal distribution; skewness = 3.862 (SE = .287), kurtosis = 22.508 (SE = .566), Shapiro-Wilk (W = .681, p < .001) demonstrating that data violated the assumptions of normality. Data was log transformed (Log10|) distribution tends to normality; skewness = -.171 (SE = .287), kurtosis = 1.616 (SE = .566), Shapiro-Wilk (W = .967, p = .065). Parametric tests will be used for the analysis of S8 acute cortisol samples.

Table 101
Means and Standard Deviations for the measure of Children's Acute Cortisol at session 8 and as a result of Intervention Condition

		Pre-intervention		Post intervention	
Condition	*N*	*M*	*SD*	*M*	*SD*
S8 All children	70	.119	.076	.093	.041
S8 Dog	35	.098	.040	.089	.033
S8 Relaxation	35	.139	.096	.096	.048

A 2 (Pre-Post) x 2 (Condition) x 2 (Gender) analysis of variance was conducted to assess S8 acute data. Levene's test demonstrated that equality of variance was not violated for pre (F (3, 66) = .484, p = .695) and post (F (3, 66) = 979, p = .408) sessions. A significant main effect for pre-post measures was confirmed [F (1, 66) = 9.784; p =0.003, η_p^2 = .129] with cortisol reducing after intervention. No main effect of condition was present [F (1, 66) = 2.651; p = .108, η_p^2 = .039], however a significant interaction for condition with time at the S8 time-point was revealed [F (1, 66) = 4.390; p =.040, η_p^2 = .062]. Planned comparisons showed that children's cortisol in the dog condition did not change significantly (t (34) = 1.109, p = .275) (pre M = .0984 µg/dL, post M = .0895 µg/dL), but those in the relaxation condition showed a significant reduction in post-acute cortisol at the S8 intervention session (pre M = .1395 µg/dL, post M = .0967 µg/dL); (t (34) = 2.997, p = .005).

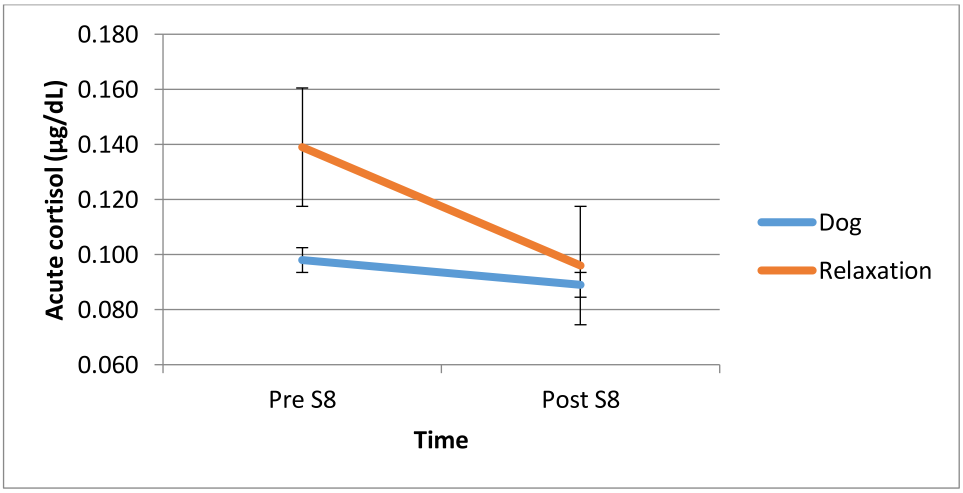

Figure 59. Mean pre-post-acute cortisol at session 8 for interaction of condition

A further A 2 (Pre-Post) x 2 (Condition) x 2 (Dog ownership) analysis of variance was conducted to assess dog ownership on acute cortisol measures at the S8 time point. A significant main effect of pre-post measure was present [F (1, 66) = 9.088; p =.004, η_p^2 = .121] with pre-intervention measures being significantly higher (M = .1190 µg/dL) than post-intervention measures (M = .0931 µg/dL). No main effect of condition was present [F (1, 66) = 2.100 p = .152, η_p^2 = .031] and an interaction for pre-post cortisol and condition just missed significance [F (1, 66) = 3.744, p = .057, η_p^2 = .054]. Planned comparisons with data split by condition shows that children taking part in dog interventions show a small reduction in cortisol although this does not reach significance (pre M = .098 µg/dL; post M = .089 µg/dL) (t (34) = 1.109, p = .275) and those in the relaxation interventions have a significant reduction in acute cortisol at S8 (t (34) = 2.997, p = .005). No main effect or interaction with dog ownership were revealed within the data for session eight.

9.4 Results: Acute cortisol, Sessions 1, 4 & 8 over the school term

Data was analysed to assess changes in acute cortisol over the school term as the interventions increased. Further analysis is carried out using a 3 (session; 1, 4, 8) x 2 (time; Pre-Post) x 2 (Condition) x 2 (Gender) or 2 (Dog ownership) ANOVA with repeated measures on the factor of time. The results presented below do not repeat the analysis conducted above but show further interactions based on differences over S1, S4 and S8 for children that provided all acute cortisol samples.

9.4.1 Sessions 1, 4 and 8 with gender

No significant effect of session was present across the data showing that acute cortisol was not significantly different across sessions one, four and eight [F (2, 86) = 2.517; p =

.087, η_p^2 = .087] and no interaction with condition was found [F (2, 86) = 2.035; p = .137, η_p^2 = .045] (see Figure 60 below).

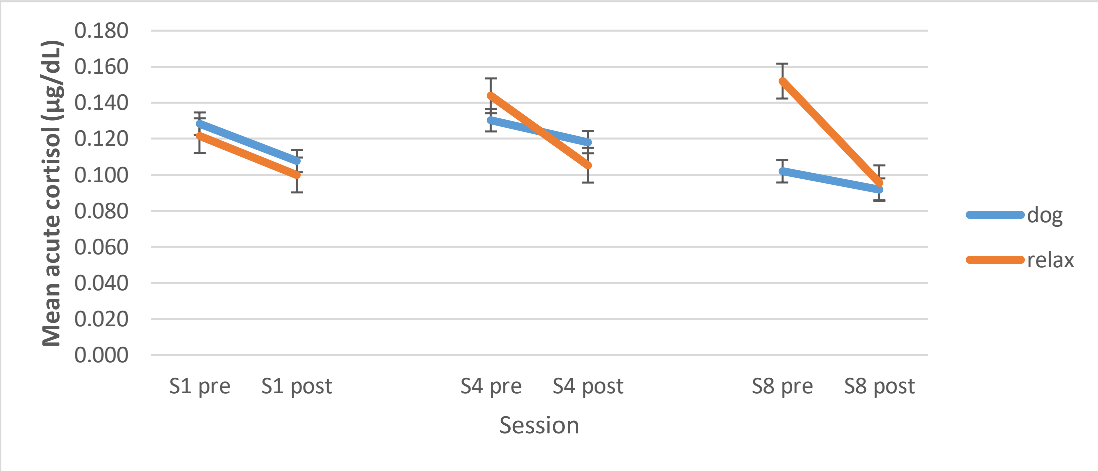

Figure 60. Mean pre-post-acute cortisol at sessions 1, 4 and 8 with condition

A three-way interaction of pre-post cortisol with condition and gender was found [F (1, 43) = 5.964; p = .019, η_p^2 = .122]. Post-hoc paired samples t-tests with data split by condition and gender revealed that only boys in the relaxation condition showed a significant decrease in acute measures of cortisol after intervention session four, all other comparisons did not reach significance once adjusted (Bonferroni; p = .004) (see Figure 61 and Table 102 below).

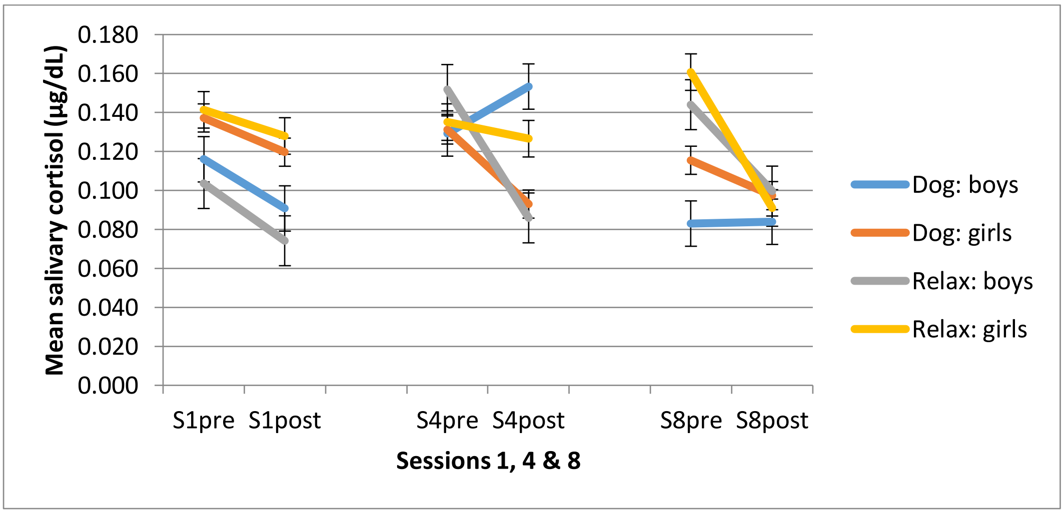

Figure 61: Mean pre-post-acute cortisol at sessions 1, 4 and 8, and interaction with condition and gender

Table 102
Acute cortisol: Post-hoc paired comparisons for three-way interaction of time with condition and gender (Bonferroni; p = .004)

Gender	Condition	Session	*M*	*SD*	*t*	*df*	*p*
Boys	Dog	S1	.060	.112	1.620	8	.144
		S4	.017	.286	-.187	8	-857
		S8	.003	.193	.051	8	.960
	Relaxation	S1	.186	.293	2.285	12	.041
		S4	.229	.224	3.697	12	.003
		S8	.144	.256	2.028	12	.065
Girls	Dog	S1	.123	.217	2.195	14	.046
		S4	.137	.225	2.351	14	.034
		S8	.048	.186	1.012	14	.329
	Relaxation	S1	-.000	.273	-.002	9	.998
		S4	.031	.163	.614	9	.554
		S8	.206	.265	2.465	9	.036

9.4.2 Sessions 1, 4 and 8 with dog ownership

A further significant three-way interaction of time (pre-post) with condition and dog ownership was revealed within the acute cortisol data [F (1, 43) = 4.709; p = .036, η_p^2 = .099]. Post-hoc t-tests with data split by condition and dog-ownership showed that children in the relaxation condition with no dog at home had a significant reduction in acute cortisol after both the S4 and S8-interventions. No other significant main effects or interactions were found (see Table 103 and Figure 62 below).

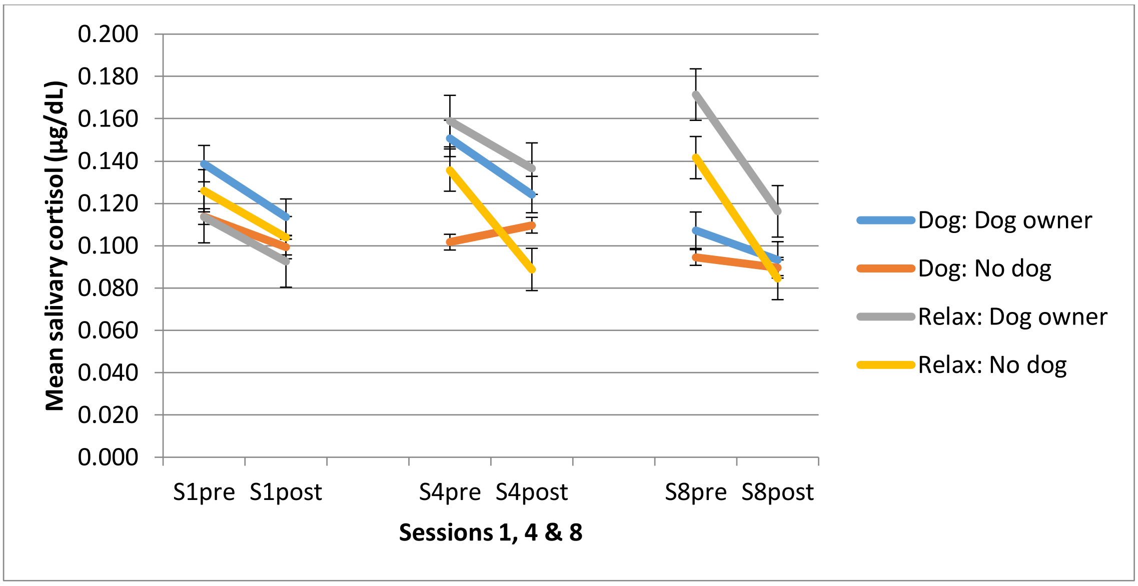

Figure 62. Three-way interaction for pre-post-acute cortisol with condition and dog-ownership (Bonferroni; *p* = .004)

Table 103

Acute cortisol, Post-hoc paired comparisons for three-way interaction of time with condition and dog ownership (Bonferroni; p = .004)

Condition	Dog ownership	Session	*M*	*SD*	*t*	*df*	*p*
Dog	Dog	S1	.125	.209	2.244	13	.043
		S4	.143	.282	1.899	13	.080
		S8	.027	.185	.550	13	.592
	No Dog	S1	.064	.147	1.374	9	.203
		S4	-.010	.191	-.181	9	.886
		S8	.037	.196	.608	9	.558
Relaxation	Dog	S1	.069	.319	.614	7	.558
		S4	.063	.238	.752	7	.477
		S8	.074	.312	.671	7	.524
	No Dog	S1	.124	.290	1.659	14	.119
		S4	.186	.204	3.525	14	.003
		S8	.223	.214	4.030	14	.001

9.4.3 Summary: Cortisol

Baseline cortisol samples were taken before intervention sessions commenced and again after completion of the 4-week intervention sessions. This was done for all children taking part in the study, including children in the control condition. Results for baseline cortisol analysis show an overall increase in cortisol, with children having increased measures of stress hormones over the course of the school term.

Whilst no significant main effect or intervention with condition was found for the baseline cortisol, planned comparisons showed that cortisol of children in the dog condition remained at the same level over the school term. Children in the relaxation condition also showed no significant increase in cortisol over the school term but this effect was not as strong as for children who had taken part in dog interventions. In stark contrast, baseline cortisol of children in the control group rose significantly from beginning to end of the school term. This result was consistent across both the one-to-one and group intervention sessions showing that overall the type of session the interventions were implemented under did not have an impact on background cortisol levels of the children.

The analysis of cortisol before interventions began demonstrated that cortisol was not significantly different based on the dog ownership status of the children. A three-way interaction for time with condition and dog ownership revealed that dog ownership produced inconsistent results across conditions. Again, children in the dog interventions showed no increase in cortisol over the school term regardless of dog ownership, whilst the children in the relaxation interventions had a significant increase if they had a dog at home. Children in the control condition showed an increase in cortisol if they did not have a dog at home although the strength of the effect did not reach significance once adjusted, however, this result must be viewed with caution due to low sample size and unequal dog ownership across those taking part with particularly low numbers of dog owning children in the control condition.

Acute cortisol samples were collected to assess whether dog-assisted intervention had an immediate impact on children's stress levels. Samples were taken before and after sessions one, four and eight, with measures reducing significantly after intervention at each of the sessions. Samples collected at session one revealed a significant decrease in cortisol after taking part in both the dog and relaxation intervention, with the dog intervention producing a stronger effect than the relaxation intervention. A significant main effect for gender was also present at session one, with girls having significantly higher cortisol before the interventions began. Girls then had a significantly greater reduction in cortisol compared to boys when measured after intervention, resulting in no significant gender difference in the post intervention measure of acute cortisol at session one.

At session four, children in the dog intervention did not have a significant reduction in cortisol after intervention, in contrast to the children in the relaxation intervention who did. An interaction of time with gender and condition revealed that girls who took part in the dog intervention had a significant reduction in cortisol whilst boys showed significant reductions if they took part in relaxation interventions. Whilst not reaching significance it is interesting to note that girls had reduced cortisol regardless of intervention condition, whereas boys had an increase in cortisol after the dog intervention at session four in contrast to those who took part in relaxation. A further interaction with dog ownership at this session revealed that reductions in cortisol were significant for those in the relaxation intervention who did not have a dog at home.

Measures of acute cortisol for session eight showed a significant interaction of time with condition, and reflect the pattern of those in session four, with children who attended the relaxation intervention showing a significant reduction in stress hormones in contrast to children in the dog interventions who did not. The results for the effect of condition type on acute cortisol is interesting when tracked from session one to eight, with those in the dog condition showing less intense reductions immediately after intervention, as their overall baseline cortisol measure reduces across the school term. This will be discussed further at a later point.

In order to investigate acute cortisol measures over the length of the school term and the impact of interventions over time, all acute measures were considered together and analysed alongside gender or dog ownership. Acute cortisol was not significantly different over sessions one, four and eight. An interaction of time (pre-post) with condition and gender revealed that boys had a significant decrease in cortisol following the relaxation intervention at session eight, whilst other comparisons across gender and condition did not show a strong enough effect to reach significance once adjusted. The further interaction of time with condition and dog ownership revealed that children who attended the fourth and eight relaxation sessions showed a significant decrease in acute cortisol. Once again other comparisons across condition and dog ownership did not reach significance once adjusted.

Looking at the wider picture, the acute cortisol data taken before and after each intervention session suggests that children in the dog condition produce less significant reductions in acute cortisol relative to those in the relaxation sessions, especially as interventions progress across the school term (see Figure 58). It is important that these observations also take into consideration that the baseline (background) measure of cortisol showed no increase in baseline stress levels for children in the dog intervention but increased significantly for those taking part in the relaxation sessions. So whilst acute cortisol reduced significantly after relaxation sessions, the pre-intervention measure also increased beyond the previous measure at each session time. It could therefore be concluded that the dog interventions mediated the effect of cortisol across the school term, whereas relaxation interventions reduced cortisol with an immediate effect but this is did not produce lasting effects as demonstrated by high pre-cortisol measures before intervention sessions.

9.5 Discussion: Cortisol

Children's measures of baseline cortisol demonstrated the positive impact of children's interactions with a dog over the school term through the moderation of stress hormones. In contrast, children in the control condition had a significant increase in cortisol, whereas those who interacted with the dogs showed no change over the school term. This is clear evidence for the successful moderating effects of AAI on stress levels in school children. This is the first longitudinal RCT working within schools to report such effects.

Acute cortisol samples to assess the immediate impact of AAI on children's physiological function were collected at sessions one, four and eight. AAI sessions resulted in immediate reductions in cortisol at session one, along with those in the relaxation interventions. This result aligns with previous research which also reported similar immediate effects (Pendry and Vandagriff, 2019; Polheber & Matchock, 2014; Beetz, et al., 2011; Beetz, et al., 2012). Surprisingly, sessions four and eight resulted in significant reductions of cortisol for those in the relaxation sessions but not for AAI. This result is interesting when looking at the wider picture of baseline and acute measures together. As the baseline cortisol measure reduced over the four-week intervention period, the children in the dog interventions had a smaller decrease in acute cortisol as the study progressed, whilst those in the relaxation sessions showed a greater decrease after each session. This maybe as a result of the baseline levels of cortisol remaining low for those in the dog condition across the study, whereas those in the relaxation sessions rose to near pre-intervention levels after the first and fourth sessions, resulting in a greater drop after relaxation sessions at each time point.

No differences between boys and girls cortisol were present in baseline samples before interventions began, confirming that stress hormones were the same for both genders at the start of the study. However, acute cortisol at session one showed that girls had significantly higher cortisol levels before the intervention began but showed a greater decrease in cortisol compared to boys which resulted in comparable post-intervention measures. An interaction at session four found different results based on gender and condition, with greater reductions in cortisol for girls in dog interventions but greater reductions for boys' cortisol in the relaxation sessions.

Baseline measures of cortisol were not different across children based on dog ownership status of families however where interactions including dog ownership were present within the data these were not of a consistent nature. Data within the dog condition found no differences based on dog ownership, whilst dog owners in the relaxation condition showed a significant increase in cortisol. Measures for the children acting as controls who did not have a dog at home showed an increase although this failed to reach significance once adjusted.

Finally, in addition to the present chapter assessing the effect of AAI on children's measures of cortisol, previous chapters have investigated cognition, language, wellbeing and behaviour. In order to complete the assessment of all measures within the longitudinal study, the following chapter will assess the effect of dog and relaxation interventions on children's sleep efficiency.

CHAPTER 10. Sleep

10.1 Measures overview for Sleep

As good quality sleep is related to children's academic and emotional wellbeing, a final measure of sleep was collected to investigate if dog-assisted interventions may have contributed to more efficient sleep patterns in children. This study measured the number of hours spent in bed and the number of hours sleeping/waking, in order to look at measures of sleep efficiency.

10.1.1 Data management, structure and analysis of Sleep

Sleep efficiency was measured using the American Academy of Sleep Medicine's (ASSM) sleep diary, completed within the home over a four- week period (see Chapter 5, subsection 5.2.4.5). Descriptive statistics were reported followed by repeated measures analysis of variance. Data was first assessed for differences across schools using one way analysis of variance. Further repeated measures ANOVAs for the effect of Time (Week1, 2, 3, 4) x Condition (dog/relax/control) with repeated measures on the factor of time were conducted. Scores were analysed for all children and then data was analysed in the same manner for one-to-one and group intervention sessions separately. Planned comparisons and post-hoc analysis were conducted, and adjustments made using Bonferroni corrections to further explore results in more depth.

10.2 Results: Effect of AAI on children's sleep

Numbers of parents returning sleep questionnaires for their children was approximately equal for those in the dog and control conditions, with only half the amount returning questionnaires in the relaxation condition. Overall, children in the relaxation condition showed better sleep efficiency than children in other conditions, as demonstrated through higher values. Scores of sleep efficiency within each condition are similar across the 4-weeks that sleep was recorded (Table 104).

Table 104
Means and Standard Deviations for the measure of Children's Sleep Efficiency over 4-week Intervention period

Condition	Time	*N*	*M*	*SD*
Dog	Week-1	25	94.467	3.910
	Week-2	25	94.561	3.596
	Week-3	25	94.904	3.887
	Week-4	25	94.792	4.928
Relaxation	Week-1	12	95.666	3.297
	Week-2	12	96.458	2.806
	Week-3	12	95.689	3.624
	Week-4	12	95.6476	3.384
Control	Week-1	21	94.006	3.297
	Week-2	21	94.848	6.032
	Week-3	21	94.227	3.281
	Week-4	20	94.638	4.007

*Note: Lower values represent worse sleep efficiency

An initial one-way analysis of variance was conducted to assess whether data collection was comparable across schools. No significant effect of school was returned in relation to average number of hours slept during the week [F (3, 57) = 1.063, p = .373, η_p^2 = .056], with children sleeping an average 10 hours per night and children's average sleep being comparable across schools. Data was therefore collapsed over schools.

A 4 (Time: intervention weeks1, 2, 3 & 4) x 3 (Condition) analysis of variance was carried out to assess sleep efficiency over the course of the intervention sessions. Mauchly's test demonstrates sphericity of the data for session time (X^2 (5) = 10.082, p = .073). No significant results, neither main effects of time [F (3, 162) = .646, p = .587, η_p^2 = .012] or condition [F (2, 54) = .541, p = .585, η_p^2 = .020], or an interaction between the two [F (6,

162) = .343, p = .913, η_p^2= .013] were returned for sleep efficiency. This demonstrated that children's sleep did not change significantly over the course of intervention period of 4-weeks and was not significantly affected by test condition. In order to investigate the effect of dog interventions on children sleep, planned comparisons were carried out. No significant differences were found between any of the consecutive weeks of sleep based on intervention condition.

10.2.1 One-to-one sessions: Sleep efficiency, 4-week intervention

A 4 (Time of intervention) x 3 (condition) analysis of variance was conducted to assess the impact of the intervention condition on children's sleep efficiency if they took part in one-to-one intervention sessions. Data did not violate the assumptions of sphericity as demonstrated by Mauchly's test (X^2 (5) = 8.633, p = .125). Once again, no significant effect of time [F (3, 123) = 0.920, p = 0.433, η_p^2 = .022], condition [F (2, 41) = 1.036, p = 0.364, η_p^2 = .048]. or interaction of time with condition 9F (6, 123) = 0.140, p = 0.991, η_p^2= .007] were returned for sleep efficiency when children took part in one-to-one intervention sessions.

10.2.2 Group sessions: Sleep efficiency, 4-week intervention

A 4 (Time of intervention) x 3 (condition) analysis of variance was conducted to assess the impact of the intervention condition on children's sleep efficiency. Mauchly's test shows a violation of sphericity (χ^2 (5) = 14.545, p = .013), therefore degrees of freedom are corrected using Greenhouse-Geisser estimates of sphericity. No significant effect of time [F (2.365, 70.943) = .134, p = .904, η_p^2 = .318], condition [F (2, 30) = .144, p = .867, η_p^2 = .288] or interaction of time with condition [F (4.730, 70.943) = .659, p = .647, η_p^2 = 3.119] were returned for sleep efficiency demonstrating that children's sleep habits did not change significantly if they took part in group intervention sessions.

10.2.3 Summary: Sleep

Intervention condition of dog, relaxation and control showed no effect on children's sleep efficiency with all children sleeping equally well. Equally, session type of one-to-one or group did not have an effect on children's sleep measures. Overall this clarifies that relaxation and dog interventions carried out for twenty minutes, twice a week and over a four week period do not have an effect on children's sleep efficiency, either gradually over the course of intervention or overall. Sleep efficiency data was not different based on gender or dog ownership status of the children.

10.4 Discussion: Sleep

Previous studies with psychiatric patients have reported the positive effect of AAI on outcomes relating to sleep (Nevins, Finch, Hickling & Barnett, 2013; Newton, 2014; for wider discussion see O'Haire, Guerin and Kirkham, 2015). Given that there is no previous research available to demonstrate the effect of AAI on typically developing children's sleep, this work is the first to show that a four week intervention with a dog did not have an effect on sleeping patterns. It can therefore be concluded that AAI may not be effective in improving sleep patterns for a typically developing cohort of children.

The following chapter brings together earlier discussions from this longitudinal study. The main discussion was structured around the original research questions and hypotheses of the study, and will evaluated the current results in light of the theoretical perspectives relevant to the field of human-animal interactions and animal-assisted interventions.

PART FOUR: Discussion and Final conclusions

CHAPTER 11: Main Discussion

This thesis contributes new and unique findings to the field of human-animal interaction and animal-assisted intervention by carrying out longitudinal RCTs with school children, employing a comprehensive range of measures. The work specifically focused on children's learning, behaviour and wellbeing previously highlighted as missing from the literature (Brelsford, et al., 2017; O'Haire, 2013b). The aim of the research project was therefore to investigate the effects of dog-assisted interventions on children's cognition, language ability, social-emotional wellbeing, behaviour, physiological function and sleep. The originality of the design included the collection of standardised data, parental/teacher views and physiological measures, with repeated observations over a one year period. Measures were collected, and interventions carried out, in classroom settings in order to assess 'what works' for schools. In addition, the effectiveness of one-to-one versus group interventions was assessed. This also allowed conclusions in relation to the feasibility and cost efficiencies of dog-assisted interventions for schools.

Summaries and discussions relating to specific results were presented in the above sections of this thesis. The main discussion will now link this work back to the original research questions and hypotheses, and highlight the original contributions of these findings to the field. Key findings of the study will be evaluated and integrated into theory, and outlook and conclusions reported.

Table 105:
Results overview: Significant main effects and interactions for all analyses

Assessment	Cohort	Analysis conducted	Significant main effects & interactions	Planned comparisons	Sig (2-tailed)	η_p^2
BAS3: Special Non-verbal composite (SNC)	All children	Time x condition x gender x dog owner	Time		<.001	.233
				- pre-post	<.001	
				- post-6-weeks	<.001	
	One-to-one	Time x Condition	Time		<.001	.260
				- pre-post	<.001	
				- post-6-weeks	<.006	
	Group	Time x Condition	Time		<.001	.250
				- pre-post	<.002	
				- post-6-weeks	<.001	
BAS3: Non-verbal Reasoning	All children	Time x condition x gender x dog owner	Time		<.001	.059
				- pre-post	.001	
	One-to-one	Time x Condition	Time		<.003	.065
				- pre -post	<.001	
	Group	Time x Condition	Time		<.001	.082
				- post-6-weeks	.011	
BAS: Spatial ability	All children	Time x Condition x gender x dog owner	Time		<.001	.278
				- pre-post	<.001	
				- post-6-weeks	<.001	
	One-to-one	Time x Condition x gender x dog owner	Time		<.001	.315
				- pre-post	<.001	
				- post-6-weeks	<.001	
			Time x condition		.034	.066
				- pre-post dog	.001	
				- pre-post control	.001	
				- post-6-weeks dog-	.016	
				- post-6-weeks relax	.020	
	Group	Time x condition x gender x dog owner	Time		<.001	.288
				- pre-post	.001	
				- post-6-weeks	<.001	

Table 105:
Results overview: Significant main effects and interactions for all analyses

Assessment	Cohort	Analysis conducted	Significant main effects & interactions	Planned comparisons	Sig (2-tailed)	η_p^2
Fruit Stroop: Congruency	One to one	Time x condition			.016	.073
Fruit Stroop: Speed of Processing (SOP)	All children	Time x condition x gender x dog owner	Time		<.001	.587
				- pre-post	<.001	
				- post-6-weeks	<.001	
				- -6-weeks-6-months	.004	
				- 6-months – 1-year	<.001	
	One to one	Time x condition x gender x dog owner	Time		<.001	.642
				- pre-post	<.001	
				- post-6-weeks	<.001	
				- 6-months – 1-year	<.001	
	Group	Time x condition x gender x dog owner	Time		<.001	.582
				- pre-post	<.001	
				- post-6-weeks-	<.001	
				- 6-months – 1-year	<.001	
Maths	All children	Time x condition x gender x dog owner	Time		<.001	.125
				- pre-post	.012	
			Gender	Boys > girls scores	.041	.049
			Time x dog ownership		.046	.029
				Pre-post dog-owner	.004	
	One-to-one	Time x condition x gender x dog owner	Time		<.001	.178
				- pre-post	<.001	
				- 6-weeks-6-months	.010	
	Group	Time x condition x gender x dog owner	Time		<.001	.137
				- post-6-weeks	.012	
			Gender	Boys > girls scores	.001	.222
Categorisation	All children	Time x animacy x condition x gender	Time		.001	.109
				- pre-post	<.001	
				- -post-6-weeks	.002	
			Animacy	Animate faster	<.001	.532

Table 105:
Results overview: Significant main effects and interactions for all analyses

Assessment	**Cohort**	**Analysis conducted**	**Significant main effects & interactions**	**Planned comparisons**	**Sig (2-tailed)**	η_p^2
Categorisation continued			Time x animacy		<.001	.204
				Animate faster: pre, post, 6-week	<.001	
			Animacy x condition		.026	.087
				Animate faster – all conditions		
	One to one	Time x animacy x condition x gender	Time		<.001	.132
				- pre-post	<.001	
				- post-6-weeks	.009	
			Animacy	Animate faster	<.001	.654
			Time x animacy		<.001	.193
				Animate faster: pre, post, 6-week, 6-month	<.001	
	Group	Time x animacy x condition x gender	Time		<.001	.146
				- pre-post	<.002	
			Animacy	Animate faster	<.001	.408
			Animacy x condition		.003	.225
				Animate faster all conditions	<.001	
			Time		<.001	.357
			x Animacy	Animate faster than inanimate: pre, post, 6-week	<.001	
			Time x animacy x condition		<.001	.198
				Dog: pre,	.001	
				post, 6-week, 1-year	<.001	
				Relax: post	.002	
				Control; pre, post, 6-week, 6-month	<.001	
			Time x condition x gender		.038	.085

Table 105:
Results overview: Significant main effects and interactions for all analyses

Assessment	**Cohort**	**Analysis conducted**	**Significant main effects & interactions**	**Planned comparisons**	**Sig (2-tailed)**	η_p^2
ACE: Sentence Comprehension	Time	Time x condition x gender x dog	Time		.001	.231
				- pre-post	.001	
				- 6-months -1year	.005	
			Time x condition x gender		.024	.050
				Dog: Boys pre-6-months	.001	
				Girls pre-post, pre-6-week, pre-1-year	<.001	
				Relaxation: Boys pre-1-year	<.001	
				Girls pre-6-week, pre-1-year	<.001	
			Time x gender x dog ownership		.004	.044
				Dog owner: Boys pre-post Pre-1-year	.001	
				Non-dog owner: Boys pre-6-month, pre-1-year	.001	
				Girls: pre-6-week, pre-6-month, pre-1-year	<.001	
	One-to-one	Time x condition x gender x dog owner	Time		.001	.228
				- pre-post	.001	
				- 6-months -1 year	.008	
			Time x gender x dog ownership		.002	.077
	Group	Time x condition x gender x dog owner	Time		.001	.247
				- pre-post	<.001	
			Time x dog ownership		.022	.057

Table 105:
Results overview: Significant main effects and interactions for all analyses

Assessment	Cohort	Analysis conducted	Significant main effects & interactions	Planned comparisons	Sig (2-tailed)	η_p^2
ACE: Syntactic Formulation	All children	Time x condition x gender x dog ownership	Time		.001	.087
				- pre-post	<.001	
	One to one	Time x condition x gender x dog ownership	Time		<.001	.118
				- Pre-post	<.001	
	Group	Time x condition x gender x dog ownership	Time		.001	.113
EQ	All children	Time x condition x gender	Gender	Girls higher than boys	.017	.093
SQ	All children	Time x condition x gender	Time	Scores reduced pre-post	.017	.092
Behaviour at home	All children	Time x condition x gender	Time x condition		.013	.137
				Dog scores decrease pre-post	.007	
Classroom behaviour	All children	Time x condition x gender	Time x condition		.033	.067
		Time x condition x dog ownership	Dog ownership		.008	.067
			Condition x dog ownership		.017	.079
	One to one	Time x condition x gender	Time x condition		.042	.097
	Group	Time x condition x dog ownership	Condition	Control better scores overall	.036	.107
			Dog ownership	Dog owning children rated as better behaved in class	.015	.096
			Condition x dog ownership		.008	.151
Self esteem	All children	Time x condition x gender x dog ownership	Time		.001	.089
				- Pre-post	<.001	
				6-months -1-year	.016	

Table 105:
Results overview: Significant main effects and interactions for all analyses

Assessment	**Cohort**	**Analysis conducted**	**Significant main effects & interactions**	- **Planned comparisons**	**Sig (2-tailed)**	η_p^2
Self-esteem continued	All children		Time x gender		.046	.028
				Girls and boys increased significantly over year		
			Condition x dog ownership		<.001	.144
	One to one	Time x condition x gender x dog ownership	Time		<.001	.106
				-post-6-week	.006	
			Time x condition x dog ownership		.028	.078
	Group	Time x condition x gender x dog ownership	Time		.003	.078
				- post-6-weeks	.006	
			Condition		.044	.122
			Time x gender		.010	.066
				Girls: pre-post	.001	
			Condition x dog ownership		.002	.233
				Dog owning children significant difference across conditions	.023	
Anxiety	All children	Time x condition x gender x dog ownership	Time		.001	.070
				- post-6-weeks	<.001	
			Condition x dog ownership		.002	.131
				Relaxation: Dog-no-dog	.004	
	One to one	Time x condition x gender x dog ownership	Time		.005	.069
				- post-6-weeks	.006	
	Group	Time x condition x gender x dog ownership	Time		.004	.076
				- post-6-weeks	.003	
			Condition		.024	.144
			Dog ownership		.045	.081
			Time x gender		.009	.067
				Boys: pre-1-year	.004	

Table 105:
Results overview: Significant main effects and interactions for all analyses

Assessment	Cohort	Analysis conducted	Significant main effects & interactions	Planned comparisons	Sig (2-tailed)	η_p^2
Anxiety continued	Group		Condition x dog		.001	.243
			ownership	Relaxation: Dog-no-dog	.007	
			Time x condition x		.040	.080
			gender	Relaxation: girls pre-1-year	.005	
Baseline Cortisol	All children	Time x condition x gender	Time	Increased over term	.001	.119
		Time x condition x dog ownership	Time	Increased over term	.001	.142
			Time x condition x		.001	.212
			dog ownership	Relax:		
				Dog owner pre-post increase	<.001	
	One to one	Time x condition x gender	Time	Increased over term	.003	.154
	Group	Time x condition x gender	Time	Increased over term	.014	.128
Acute cortisol Session 1	All children	Time x condition x gender	Time		.001	.212
			Gender		.030	.077
				Girls: pre higher	.022	
		Time x condition x dog ownership	Time	Increased over term	.001	.210
Session 4		Time x condition x gender	Time	Increased over term	.001	.207
			Time x condition x		.006	.115
			gender	Relaxation: Boys decreased:	.002	
				Dog: Girls decreased	.001	
		Time x condition x dog ownership	Time	Increased over term	.001	.164
			Time x condition x		.026	.076
			dog ownership	Relaxation: No dog	<.001	
Session 8		Time x condition x gender	Time	Increased over term	.003	.129
			Condition x time		.040	.062
				Relaxation decreased	.005	
		Time x condition x dog ownership	Time		.004	.121

11.1 Hypothesis 1: Learning and Maturation

It was predicted that there would be general learning and maturation effects: cognition, socio-emotional and behavioural measures.

The hypothesis that general learning and maturational effects would be found for this cohort in cognition and language was supported with highly significant main effects of time being present for all measures collected through the BAS (SNC, NVR and spatial ability), the ACE (SC and SF), the maths task, and experimental measures of categorisation and Stroop SOP (Goswami, 2015; 1998). Time generally accounted for a large amount of variance not accounted for by other factors within the models. Children performed as expected due to the developmental progress of typically-developing children attending school on a full-time basis learning tasks which improve cognition, language and mathematical skills as part of the curriculum. Additionally, children's baseline measures also demonstrated that the mainstream schools involved in the project did not differ significantly between each other.

It is noteworthy that children's measures within this study did not always follow a linear pattern **(**Ayoub & Fischer, 2006; Reilly, 2000), i.e. significant increases were not found between all consecutive test times. Regardless of this, children did show significant improvement in learning between baseline and the 1-year test points which is a positive reflection not only of children's learning abilities and progress, but also of the schools' impact on children's outcomes.

Socio-emotional data also provided support for the hypothesis of developmental and maturational effects with both the self-esteem (CFSEI) and anxiety (RCMAS) measures showing significant improvement with time. The improvement seen in children's measures of self-esteem fits with wider literature such as that of Rosen (2016) and Stets and Burke (2016) suggesting that perceptions of self- worth change as the child develops and are exposed to new experiences and relationships with others. Being part of the study may have increased children's favourable attitudes towards themselves resulting in improved scores over time regardless of the condition they took part in. Similarly, children's scores of manifest anxiety also improved, showing a decrease over the school term. This result for anxiety, combined with the reduced measures of self-esteem fit with literature asserting an overlap between the two factors (see Keane & Loades, 2017 for overview).

The empathy and systemising (EQ-SQ) measures revealed interesting results with empathy (EQ) failing to show changes over time, whilst the systemising element (SQ) showed a significant reduction in systemising scores with time. Whilst both the EQ and SQ are part of one assessment tool, they do measure different functional behaviours. Systemising measures a person's tendency to construct systems and follow rules in their thought processes (Auyeung et al., 2009; Baron-Cohen, Aswin, Ashwin, Tavassoli & Chakrabarti, 2009; Baron-Cohen, et al., 2005). This result of reduced systemising most likely represents increased flexibility for the children involved. It is possible reduced systemising behaviours are linked with other factors such as anxiety levels (Strutt, Campbell & Burke, 2014), which also reduce over the course of this study.

As there were no changes in empathy, it may be that the interaction between anxiety and empathy manifests itself in a different way (Knight, Stoica, Fogleman & Depue, 2019; Strutt, Campbell & Burke, 2014), and follows a developmental trajectory (Decety, 2010) and is therefore impacted differently to that of systemising behaviours. This topic would need further investigation, but would be useful knowledge for future studies and for comparison with special populations, such as those with ASD.

Measures of children's behaviour at home and within the classroom did not reveal overall significant differences between the start and end of the school term. The results did therefore support the hypothesis that there would be maturational effects.

In sum, the first hypothesis of this study concerning expected learning and maturational effects was confirmed for cognitive and language measures. The hypothesis was partially supported in relation to the socio-emotional data, with emapthy failing to show and maturational effects, but the systemising behaviours showing reduction with time. Lastly the parent and teacher reports of children's behaviour at home and within the classroom did not show overall effects of time and therefore did not align with the first hypothesis. Assessments took place before and after interventions, and more detailed gathering of data from parents and teachers was beyond the scope of this thesis but would be useful in future studies. The results here do establish a pattern of development for SQ for the first time. This will also be useful for future research into empathy and systemising, and for comparison with clinical groups (for example those with ASD). As these results relate to the effects of time only, results over time in conjunction with intervention effects will be presented next.

11.2 Hypothesis 2: The effect of intervention condition

Intervention effects between groups when comparing before and after interventions were expected as follows:

a. Children taking part in dog-assisted interventions will show significant improvements in cognitive, socio-emotional, behavioural, sleep and physiological measures compared to children in the relaxation and no treatment control conditions.

b. The relaxation intervention will also show effects on measured outcomes, however, it is expected to be less effective than the dog intervention.

c. Children in the no treatment control condition will show least or no improvements in measures. Any changes in this group will only come about via maturation and learning.

11.2.1 Effect of intervention condition on children's cognition

Children's cognitive abilities were assessed through the BAS toolkit, allowing for a Special Non-verbal Composite (SNC) score which was made up of scores from the subtests of non-verbal reasoning (NVR) and spatial ability (SA). Next to the above described improvements for tasks within the BAS, specific intervention effects were also demonstrated for dog and relaxation interventions. The effects for overall cognition measured through the BAS (SNC scores) and spatial ability supported the hypothesis, with dog interventions showing some benefits to cognition, followed by the relaxation interventions, with those who acted as controls making no improvements. Caution must be stressed in interpreting improvements, as whilst these results are interesting, the lack of interaction effects for intervention condition with time, demonstrated that overall the intervention conditions did not show statistically significant differences from each other. Interestingly, these trends in cognitive improvements were consistent with the cortisol data reported in this study showing low cortisol over the school term than those in the relaxation sessions. Non-verbal reasoning (NVR) scores also showed a beneficial effect of the dog but only for children in the one-to-one sessions (to be discussed later within this thesis). In contrast, the relaxation condition showed no beneficial effects on NVR alongside the control condition.

The spatial ability (SA) and special non-verbal composite scores (SNC) (which incorporated an element of SA) also showed beneficial effects of the one-to-one dog interventions. These tasks involved children predominantly using short-term memory processes and spatial visualisation which represent flexible cognitive processes. These processes can be influenced by a variety of factors such as emotion, learning and stress (Blasiman & Was, 2018). Emotions can have a positive effect on spatial working memory, with affective states influencing integration of information during processing (Storbeck & Maswood, 2016; Gray et al., 2002). Linked with previous findings of positive effects of AAI on memory (Gee et al., 2012a; Hediger & Turner, 2014) it could be suggested that children benefited from positive emotions as a result of interaction with a dog, and therefore gained an immediate benefit of the AAI on the processing of SA (and SNC scores which incorporated a measure of SA). The current study also found a moderating effect of AAI on children's cortisol levels which is also associated with efficient executive functioning (Shields, Sazma & Yonelinas, 2016; Wagner, Cepeda, Krieger, Maggi, D'Angiulli, Weinberg & Grunau, 2016).

The effect of AAI on children's maths scores did not support the hypothesis for an improvement in scores based on intervention condition as neither the dog or relaxation interventions helped impove children's maths scores. Instead, children's maths performance improved significantly for all condition types over the course of the one year study and showed comparable effects. Assessment carried out over consecutive test times did not show any significant differences between conditions. This result is interesting given the results of the cognitive tasks above and the fact that the processing of maths also involves many of the same functions as those performed in the SA and SNC such as short-term working memory and visuospatial processing (Kyttälä, Kanerva, Munter, & Björn, 2019; Kytällä & Lehto, 2008; Henry & MacLean, 2003; Holmes & Adams, 2006). One reason for this lack of effect could be the arithmetic task itself. The task was designed to be stressful for the children with difficult arithmetic to be calculated within a small timeframe. Children's progression in maths skills may not have be sufficiently rapid enough for the effects to be evident between consecutive assessments. As varying cognitive components are involved in the processing of maths, and these differ with age and due to task demand (Kytällä, et al., 2019; Kytällä & Lehto, 2008; Henry & MacLean, 2003; Holmes & Adams, 2006; McKenzie, Bull & Gray, 2003) further research will be required. Higher stress levels for this task may have counteracted the otherwise potentially beneficial effects of dog or relaxation interventions.

Further research would need to assess the effectiveness of interventions on differing stress levels. In addition, the processing of maths carried out in the presence of a dog may also assist children with maths more effectively. Future research looking at the intensity of effects in the presence of a dog could to help answer this. The application of AAI for the improvement of children's maths (arithmetic in particular) within the classroom cannot be recommended. This is the first evidence of this kind and the current study has provided an original contribution to the field of AAI and children's maths skills.

A further cognitive task, the Fruit Stroop task was administered to provide a more in-depth assessment of AAI in relation to executive functioning, inhibitory control in particular. On the whole the results for children's processing of the Fruit Stroop task were consistent with previous literature (Okuzumi, 2015). Results for the processing of congruency revealed that the dog condition had the predicted significant effect on interference scores immediately after intervention. Other conditions failed to show such improvements. This confirmed the hypothesis that AAI with a dog would have beneficial effects over those of other conditions in the processing of congruency. Children's speed of processing (SOP) of the Stroop task were in line with previous research showing that children's processing time increases with age (Duell, et al., 2018). Again, as predicted, children who took part in dog interventions showed significant improvements in SOP, whilst those in the relaxation and control conditions did not. Processing of congruency required the child to supress certain information whilst attending to other, more relevant information in order to perform efficiently. The previous discussion for the cognitive tasks highlighting the contribution of short-term working and the effect of wider processes such as emotion, learning and stress (Blasiman & Was, 2018; Storbeck & Maswood, 2016; Gray et al., 2002) is also relevant to the processing of the Stroop task. Importantly, attentional processing which the Stroop task relies on is linked with, and can be affected by emotional processing (Ling et al., 2016; Kilpatrick &

Cahill, 2003; Phleps, Ling & Carrasco, 2006). As discussed above, the cortisol results in this study also demonstrate the moderating effects of dogs on children's cortisol – which in turn is also intimately linked with executive function (Shields, Sazma & Yonelinas, 2017; Wagner, Cepeda, Krieger, Maggi, D'Angiulli, Weinberg & Grunau, 2016). This lends support to the idea that the presence of an animal can have an effect on executive functioning by producing an efficient learning state (e.g. Ling et al., 2016); the contribution of the dogs may well have had a beneficial effect on the children's processing the Stroop through this process. The results for the effects of AAI on the cognition and Stroop tasks show promise of aligning with the Biopsychosocial Model of stress proposed by Friedmann and Gee (2017) (see Chapter 2 for overview). This will be integrated with wider findings from the study and discussed further at the end of this chapter.

11.2.2 Effect of intervention condition on children's language

Children's language abilities were assessed though the ACE toolkit, which allowed the testing of sentence comprehension (SC) and syntactic formulation (SF) (grammar). Overall, children's SC showed similar improvement in both the dog and relaxation conditions over the year. Analysis of results over consecutive test times for the SC scores supported the hypothesis of an improvement for those in the dog condition. Children in the relaxation condition, and those acting as the controls did not show improvement in scores further supporting the hypothesis for the effect of AAI. These results are consistent with previous literature investigating sentence comprehension (Le Roux, 2014). These findings enhance the knowledge on AAI and sentence comprehension in particular. This research is the first to investigate the effects of AAI on sentence comprehension in children and shows the predicted beneficial effects of dog-assisted intervention immediately after intervention.

In contrast, no significant improvements in syntactic formulation (SF) occurred over the year for any condition, and no effects for the dog interventions were found for children's SF scores between consecutive test times, therefore it can be concluded that dog interventions did not assist in improving children's grammar. It may be that grammar is slower to develop as it requires the development, maturation or learning of the complex rules and structures of language (Saxton, 2017) rather than being affected by four-week-long interventions, or wider social factors in a rapid fashion. Thus, the hypotheses were not supported for the measures of SF with significant improvement seen in children who took part in one-to-one relaxation sessions, compared to those in the control and dog interventions who did not. The improvement for those in the relaxation interventions may be due to the regulation of stress (Telles, Singh, Bhardwaj, Kumar & Balkrishna, 2013; Hagen & Nayar, 2014; Mendelson, Greenberg, Dariotis, Gould, Rhoades & Leaf, 2010). Relaxation and yoga type techniques have been found to enhance performance on tasks that involve selective attention, concentration and mental flexibility (Sarokte & Rao, 2013; Pradhan & Nagendra, 2009; Sarang & Telles, 2007).

Categorical processing forms the underlying basis for the development of language and is an important aspect of wider cognitive abilities. This current study extended previous literature which reported the beneficial effects of AAI on categorisation abilities (Gee et al., 2012a; 2012b) by assessing the task with a more precise reaction time measure (RT) and through a rigorous longitudinal RCT. Results partially confirmed the hypothesis that dog-assisted intervention would benefit children's processing of animacy over and above those in the relaxation and control conditions. Both the dog and relaxation conditions both resulted in highly significant improvements for children over the one year study. In contrast, data for the children who acted as controls failed to reach significance and so confirmed the hypothesis that children in the control condition would make no improvement.

Overall, the assessment of the processing of animacy over consecutive test times showed that whilst both the dog and relaxation conditions resulted in immediate improvements, the children who had taken part in the relaxation sessions showed a slightly greater improvement than those in the dog sessions (differences in results based on session type will be discussed later within this thesis). This does not align with the hypothesis of the effects of AAI as it shows a reverse pattern of results. However, those in the control condition still failed to make a significant immediate improvement, confirming the part of the hypothesis that the children in the control condition will have the poorest performance overall.

The significant effect of the processing for children who participated in the relaxation sessions fits with wider literature asserting the beneficial effectsof such sessions on children's selective attention, concentration and mental flexibility (Sarokte & Rao, 2013; Pradhan & Nagendra, 2009; Sarang & Telles, 2007), which are all integral to this task. Equally, the beneficial effects of dog-assisted interventions have also been shown in relation to children's categorical processing of animacy (Gee et al., 2012a; 2012b). It is therefore difficult to assert a single theoretical framework in which to position this finding. The preferential processing of animate stimuli (Ohman et al., 2001; LoBue, 2010; LoBue & DeLoache, 2008; New, et al., 2007) and an evolutionary attentional bias for animacy benefiting the observer (Yang, Wang, Yan, Zhu, Chen & Wang, 2012) would result in the same effect regardless of condition the children took part in. However, the children in the control condition did now show any immediate improvement in processing animacy, whilst those in dog and relaxation conditions did. Again, this shows a preferential impact for the dog intervention, but also one for those in the relaxation condition which cannot align with the Biophilia Hypothesis as the meditation did not involve direct animals or the countryside which are prerequisites of the theory (Wilson, 1984). It seems more appropriate to conclude once again that the results fit best with the Biopsychosocial Model whereby stress reduction may be integral to the superior processing seen in both dog and relaxation conditions. These results will be discussed further in light of the physiological findings later within the discussion.

11.2.3 Effect of intervention condition on children's socio-emotional measures

There were no effects of AAI on children's empathy as investigated through the Empathy Quotient (EQ). Additionally, dog-assisted interventions did not show beneficial improvements in emotional processing of children above those in the relaxation and control conditions. The results are consistent with the findings in Donaldson (2016) who found no effect of AAI in pre-school children on emotional recognition and prosociality, and with those of Beetz et al., (2013) who found no effect of dog-assisted intervention on children's emotional regulation. However, this result is surprising, given that the dog-assisted interventions included learning about dog behaviours as well as direct interactions in getting to know the dog .The results found here do not fit easily with the literature relating to children's relationships with animals and increased empathy (Hawkins, et al., 2017; Schmid, 2011; Daly & Suggs, 2010; Daly & Morton, 2006; Williams et al., 2010; Melson, 2003, Melson et al., 1992; Bryant, 1985). Justifiably, the authors point to a more complex picture. Again, further research with carefully designed studies will help to shed light on this result.

Children's systemising (SQ) behaviours decreased significantly over all children between the baseline and post intervention tests, and children in dog-assisted and relaxation interventions did not show significant changes in their SQ scores, with no improvement present within any condition. The application of the EQ and SQ to AAI research is novel, therefore this result represents an additional contribution to the field and informs research about the limitations of AAI in typically developing populations in addition to the benefits. Systemising (an aspect of sensory processing) is related to internalising and externalising behaviours in addition to wider challenging behaviours (Dean, Little, Tomchek & Dunn, 2018). Similarly, O'Haire et al., (2013) reported that children with ASD had significantly improved social skills and less problems behaviours after intervention with guinea pigs. Results would benefit from extension of the research with RCT to include a population which would rate more extreme scores on the EQ-SQ measure, for example special needs populations with Autism Spectrum Disorders (ASD) to assess the effects of AAI on specific aspects of children's functioning.

Children's self-esteem was measured through the Culture Free Self-Esteem Inventory (CFSEI). Whilst a main effect of time demonstrated that self-esteem increased over the school term, overall there were no significant effects of interventions. However, the children in the relaxation and control conditions showed significantly increased self-esteem, whilst those in the dog intervention did not show such increase. This result failed to support the hypothesis that the dog intervention would provide benefits above those of other conditions. In contrast to previous research which highlights the positive effects of animal-assisted interventions on children's measures of self-esteem (Schuck et al., 2018), social functioning (O'Haire, et al., 2013; 2014), and the effects of animal ownership on self-esteem, which implies interaction and contact with an animal (Winsor & Skovdal, 2011; Bryant, 1990; McNicholas & Collis, 2001) the findings from this study failed to demonstrate such a benefit to children.

Measures of children's anxiety were collected through the Revised Manifest Anxiety Scale (RCMAS) and showed a decrease over the year, with children in the relaxation interventions having a significant reduction in scores above those of the dog and control conditions. Anxiety did not reduce significantly for any condition when comparisons were carried out between each consecutive test time. AAI sessions therefore failed to demonstrate a significant impact on children's measures of anxiety. It is of note that very few children within the study reported high anxiety before interventions began. This is good from the perspective of the wellbeing of the children but may be an important factor in the lack of results found in relation to dog-assisted interventions within the study, as there was no measure to effectively reduce. Unfortunately, there is very little research relating to AAI and children with anxiety. Those studies that are available often involve hospitalised children and pet ownership, so are not directly comparable to the research here, nevertheless studies such as Barker, Knisely, Schubert, Green and Ameringer (2015) and Tsai, Friedmann and Thomas (2010) where children's anxiety would be potentially higher due to adverse conditions through hospitalisation, also failed to find significant beneficial effects of a dog on children's measures of anxiety. This is in contrast to the results for pet ownership that show reduced levels of anxiety in dog owning children (Gadomski et al., 2015).

11.2.4 Effect of intervention condition on children's behavioural measures

Children's behaviour was assessed in the home through parental report and in the classroom through teacher report. Ratings were collected before and after intervention.

Surprisingly parental reports of children's behaviour at home revealed that children in the dog condition were perceived as displaying a significant decline in behaviour, whilst those in the relaxation and control conditions were rated as having no change in behaviour. This could be due to excitability and the fact that children allocated to dog interventions were particularly eager or enthusiastic in their behaviours and this may have carried into the home environment. Future research will have to investigate this pattern of results in more detail.

Behaviour in the classroom showed no significant improvement after interventions as rated by the teacher. Contrary to the hypothesis, the dog condition did not provide benefits to children's classroom behaviour above those of children in the relaxation and control sessions. There is no previous research specifically looking at individual children's classroom behaviour in relation to animal-assisted intervention longitudinally. The closest comparison which can be made is to the research conducted by Hergovich et al., (2002) and Kotrschal & Ortbauer (2003) who found increased classroom cohesion where a dog was present. The research within this project did not show an advantage of the dog or relaxation interventions on children's behaviour within the classroom. It is worth noting that Hergovich et al., (2002) and Kotrschal & Ortbauer (2003) both involved dogs being in the classroom on a continual basis, as opposed to interventions twice per week over four-weeks, which was the case in this study. The fact that the dog was present during children's interactions within the classroom may also have made a difference to group behaviour. Additionally, the previous research was based on teacher rating of classroom function as a whole, rather than specific behavioural questionnaires for each child.

11.2.5 Effect of intervention condition on children's sleep

Children's sleep efficiency was not affected by dog interventions showing that AAI applied as a school intervention for four weeks does not have a beneficial effect on typically developing children's sleep efficiency. These results lead the research field of AAI in relation to children's quality of sleep as there is no previously published research in this area. Of note, is that whilst it could be that the intervention conditions were not impacting on sleep quality or patterns, it is also possible that the sleep diary was not a precise enough measure to capture the data required to test this question. For instance, the questionnaire required the parent to record the time their child went to bed and got up each morning, and also any periods awake during the night. As the children were typically developing and would not necessarily wake parents through the night, only a few parents registered periods of waking, and in these cases, it was usually when the child was ill. If a child is awake or restless, and they stay in bed, then the parent would be unaware that they awoke and so this information would not necessarily be recorded. Further assessment of the effect of dog-assisted intervention on sleep patterns and quality of sleep could be gathered through real-time data collection of wrist devices that monitor bodily function during the night. In addition, it would be useful to assess the effect of AAI on sleep with specific cohorts of children who have sleep problems using the same measures, such as those with special educational or medical needs, in order to advance the results reported here.

11.2.6 Effect of intervention condition on children's physiological function.

Striking effects of the dog intervention were discovered for both baseline and acute cortisol measures. Children's baseline salivary cortisol which is an indicator of stress levels showed a significant increase across the school term. This increase was greatest in the children in the control condition who had participated in lessons as normal. The children in the relaxation condition showed less increase in stress levels than the controls, and the children who took part in the dog-assisted interventions showed no significant increase in salivary cortisol over the school term. It can therefore be concluded that the dog intervention had a strong mediating effect on children's stress levels, with the relaxation intervention showing lesser effects and children without an intervention who took part in lessons as normally experienced the highest stress levels from school start to the end of term. This result supports the hypothesis that AAI would benefit children's physiological function beyond those of the relaxation and control conditions.

These results represent a new and important contribution to field of AAI for the effect of dog-assisted interventions on children's physiological function within school settings. Not only has baseline cortisol in the educational setting not previously been assessed over the school term, but this also represents the first collection of baseline cortisol in conjunction with AAI in children. No previous research is available to compare results to, but overall the results align with previous research relating to acute measures which show a reduction in cortisol for those in the dog sessions (Pendry & Vandagriff, 2019; Beetz et al., 2011; Beetz et al., 2012).

This study also makes an additional original contribution to the field of AAI by showing interactions with acute cortisol and intervention condition during the school term. Whilst acute cortisol was not significantly different between sessions, differences within sessions based on condition were evident, and as a result, viewing the pattern of results over the school term is interesting. Initial reductions in cortisol after intervention one showed that the dog produced the strongest effects with an immediate reduction in cortisol. This result fits with previous research demonstrating a reduction in acute cortisol in the presence of a dog (Pendry & Vandagriff, 2019; Beetz et al., 2011; Beetz et al., 2012). A reduction was also found for those in the relaxation group, albeit to a lesser extent. The impact of dog interventions on acute cortisol then shows less effect with no significant reduction at sessions four and eight, whilst those in the relaxation sessions had significantly larger reductions as time progressed. Observation of the results in light of the baseline cortisol shows that over time the cortisol of those in the dog interventions is showing no increase which results in a lower pre-intervention acute measure at sessions four and eight. In contrast, those in the relaxation sessions show an increase in baseline cortisol over the school term and so have higher pre-intervention measures before sessions four and eight. Due to the reported benefits of yoga and relaxation on stress and anxiety (Wang & Hagins, 2016; Telles, Singh, Bhardwaj, Kumar & Balkrishna, 2013; Hagen & Nayar, 2014; Mendelson, Greenberg, Dariotis, Gould, Rhoades & Leaf, 2010) such activities are often implemented in schools in order to support children’s mental health (Waters et al., 2014; Serwacki & Cook-Cottone, 2012). As within the field of AAI, there is a distinct lack of high-quality research relating to the direct measurement of relaxation techniques in schools through physiological measures. Butzer et al., (2015) carried out a pilot study, which did not have a control group, collecting acute cortisol over one session of yoga in schools and found no significant reduction in stress hormones. The current study therefore contributes further original and valid research confirming that the relaxation intervention was clearly effective at reducing cortisol with immediate effect which resulted in significant reductions after each intervention. Importantly, the effect of relaxation did not produce longevity, resulting in a rise in baseline levels over the school term and high pre-intervention cortisol at each subsequent session.

In sum, the dog-assisted intervention had a stronger effect on children’s salivary cortisol levels than the relaxation condition. Results demonstrated that relaxation-interventions can benefit a child by reducing acute levels of cortisol. However, concentrations quickly revert back to pre-intervention levels, whilst the children interacting with the dogs showed a longer lasting, low level of cortisol.

While post intervention baseline samples were carried out after all interventions had been completed, it would be interesting to assess the longevity of salivary cortisol reduction in relation to dog-assisted interventions, to look at how long the lowered cortisol lasted after interventions had ended; this type of long-term investigation with cortisol would be very useful, but would also require high funding levels as cortisol analysis is costly.

In summing up the effect of dog-assisted interventions on children’s physiological functioning it can be concluded that the study hypothesis has been confirmed as the dog interventions led to sustained lowest stress levels in the children over the 6-week school term. Intermediate effects were found in the relaxation condition, but children in the control condition showed a steady increase in cortiol from school beginning to school term end, with the highest stress levels of all groups.

The application of a dog in educational settings may therefore beneficially support children and may be particularly useful to certain groups of children who do not perform efficiently due to high stress levels. It is important however, that further work is conducted to assess the effect of these lower levels of cortisol on immediate task demands in more detail. Effects may be more pronounced in populations of children who report with higher cortisol levels (such as children referred through mental health services of those with ASD).

11.3 Hypothesis 3: The effect of intervention over time

It was predicted that:

a. There will be longitudinal improvements in children's cognitive, socio-emotional, behavioural and physiological measures

b. Immediate pre- to post- intervention improvements will be stronger than longitudinal improvements.

In order to assess the immediate and long term effects of AAI on children's cognitive, socio-emotional and behavioural function assessments were carried out at baseline, post-intervention, after 6-week, 6-months and then at the 1-year time point. Overall, the results of the study strongly confirmed the hypothesis that immediate effects for AAI interventions would be stronger than longitudinal ones. These include measures of cognition (SNC, SA, Stroop congruency scores, Stroop SOP) and language processing (SC, categorisation of animacy). Whilst the AAI had a significant immediate effect on children's scores, this was also the case for those in the relaxation condition for some measures, including cognition (SNC, SA, Stroop SOP) and language processing (SF, categorisation of animacy). In comparison, children in the control condition mostly showed no immediate improvements.

There were very few longitudinal effects for AAI with follow up assessments at the 6-month and 1-year test times showing mostly no improvement over consecutive test times. Measures of SNC, SA and Stroop SOP showed improvement in the AAI condition up to the 6-week test time, whilst scores of SC, categorisation of animacy and Stroop processing of congruency failed to improve past the post-intervention assessments. It is important to stress that longitudinal results were present for the measurement of tasks over the academic year for cognition (SNC, SA, Stroop SOP, maths) and language (SC, categorisation of animacy), but as these were comparable across conditions, they are more likely to represent developmental and maturational improvements (see Subsection 11.1 above for specific measures and wider discussion).

Not all socio-emotional and behavioural measures were collected over the school year, for example, empathising (EQ), systemising (SQ), classroom and home behaviour questionnaires. These aimed to gain immediate feedback from teachers and parents following intervention. Immediate effects were found for children who took part in AAI with a decline in behaviour at home which supports the hypothesis of immediate effects for AAI, however, classroom behaviour and empathising did not align with this hypothesis as no change in scores was present after interventions and no differences was observed as result of AAI interventions.

Socio-emotional measures of self-esteem and anxiety were collected over the longitudinal study with neither demonstrating specific long-term benefits of children being in the AAI sessions. No immediate improvements effects of interventions were found either. These results do not align with the hypotheses that there will be longitudinal improvements, or that immediate effects of AAI would be stronger. For more in-depth discussion see subsection 11.2 above.

Due to financial constraints, it was not possible to collect longitudinal cortisol data after interventions had ended. However, the results for baseline measures showed longevity over the duration of the school term for those taking part in AAI. This is consistent with the hypothesis that AAI would result in longitudinal improvements. Ideally, the results here require extension in order to assess how long effects can last after interventions end. With regards to immediate effects, acute measures for AAI showed less strength compared to the relaxation, but this must be viewed in light of how baseline levels of cortisol are moderated during AAI and therefore impacted on acute measures over the school term (for detailed discussion see Chapter 9 & Subsections 11.2.6 above).

This current research has been carried out with the highest possible scientific rigour employing randomised controlled trials, which represents the gold standard for measuring effects of AAI interventions which supports the validity of the results.

This study is also unique, in that there are no previous longitudinal studies carried out in schools which have assessed the effect of AAI on children's cognition, as well as language, socio-emotional skills, behaviour and physiological data over a school year (see Brelsford et al., 2017 for overview). Beetz (2013) who studied the effects of a dog being continuously in a classroom over the course of a school year failed to show a significant effect for scores of depression and emotional regulation strategies. However, children did report improvements in their attitudes towards school. Previous research involving interventions in schools lasted between one- and three-months long, and have also reported mixed results across different areas of child development (Donaldson, 2016; Hergovich 2002, Kirnan et al., 2015; Tissen et al., 2007). Those that have reported significant longer term effects often involved children with special educational needs or were made up of small case studies (O'Haire, 2013; Anderson, 2006; Bassette & Taber-Doughty, 2013) making it difficult to compare the lack of significant longitudinal effects in this study to previous ones. However, the current results with typically developing children ar encouraging. They support the results of previous studies which have tested AAI during one-off test sessions, or within relatively short timeframes, and which have overwhelmingly reported significant effects of improvement (Gee et al., 2007; Gee et al., 2009; Gee et al; 2010a; Gee et al., 2010b; Gee et al; 2012a; Gee et al., 2012b) (for wider discussion see Brelsford et al., 2017). Studies such as those of Gee et al., (2007, 2009, 2010a, 2012a) and Bassette & Taber-Doughty (2013) report that animal-assisted interventions impact on children's motivation and engagement during cognitive tasks, which could account for the immediate effects of the dog condition found within this study, and the observation that improvements do not continue once interventions have ended.

11.4 Hypothesis 4: Effect of session type

It was predicted that group and individual intervention sessions will lead to the same improvements in cognitive, socio-emotional, behavioural and physiological measures.

Assessment of the type of intervention session the children took part in was interesting, as this allowed to a certain extent the discussion of quality and quantity of the interactions. Whilst all sessions were structured in a similar manner, each session was child-led in terms of the interactions and discussions which occurred. In general, it can be said that for the children in the one-to-one sessions the interactions were more personal and more individual time with the dog was available, whereas children in group interventions had less personal time with the dog but group dynamics of the children may have represented an added factor.

11.4.1 Effect of session type and intervention condition on cognition

Observation of effects based on session type allowed for the conclusion that overall, one-to-one dog-assisted sessions showed more immediate effects on children's cognition. When investigating the effects of AAI based on consecutive test times, children's cognitive scores (SNC and NVR) showed significant immediate improvement if they took part in the dog one-to-one sessions but not in the group. Spatial ability scores showed the same pattern with an immediate improvement for the dog one-to-one sessions. Those in the dog group sessions also saw an increase in SNC scores but a later time point between the post-intervention and 6-week tests. Neither session type showed significant effects for the relaxation intervention, or benefited children's longitudinal improvement for any of the conditions. The effect of session type on immediate maths scores was not evident, with neither one-to-one nor group sessions producing beneficial effects.

For the Stroop tasks, one-to-one dog-assisted interventions benefited children's processing of congruency (between baseline and 1-year tests) which was not seen in the group results or other conditions. However, neither session type was seen as advantageous for the processing of congruency to both the dog or relaxation sessions when assessed over consecutive test times. Speed of processing (SOP) the Stroop task showed no improvements for those in one-to-one dog intervention, but significant improvements for those in the relaxation sessions. The opposite pattern is seen in the group intervention with improvements in SOP for those in the dog sessions but not for the relaxation. Overall, it would appear that the different session types may be more effective depending on the type of intervention being implemented when considering the processing of Stroop type tasks. For example, the lack of effects for SOP in the one-to-one dog sessions reflects that the children are processing the task slower but when considered alongside the congruency scores, whilst not quite reaching significance, the children in the dog one-to-one sessions show the strongest effect of reduced interference. Therefore the AAI may be creating a trade-off between the two, with better processing of congruency through slower processing.

In conclusion, the hypothesis that there would be no difference between session types is rejected, with the one-to-one AAI sessions overall showing more significant results for cognitive tasks than the group interventions. It is advisable to tailor future interventions taking these differential results into account. This will enable the optimising of interventions for specific tasks. As this study is the first to report such effects of AAI looking at executive functioning in the processing of the Stroop, further research is required in order to tease apart and extend these findings.

11.4.2 Effect of session type and intervention condition on language

The effect of session type on the processing of animacy in the categorisation task was mixed and inconsistent across conditions. Results over the one-year study showed significant improvement in processing of animacy for all children in the one-to-one intervention sessions with the AAI showing the strongest effect. Group sessions showed that that those in the relaxation group performed the best over the year with AAI showing the worst performance. However, when looked at in terms of consecutive test times, only children who took part in one-to-one relaxation and dog interventions showed significant improvements, with the relaxation showing a highly significant improvement in the processing of animacy. No significant improvements were present for interventions carried out as group activity. It can therefore be concluded that one-to-one sessions preferentially enhanced the processing of animacy immediately after intervention for both dog and relaxation interventions, but that neither session type was superior based on processing over the year. Previous literature asserting the beneficial knowledge gained from pet ownership and interactions with animals (Geerdts, Van de Walle & LoBue, 2005; Prokop, Prokop & Tunnicliffe, 2008) may have improved processing of animacy through the quality of the interaction allowed between child and dog during one-to-one sessions. Nonetheless, as the relaxation condition also improved, and with a highly significant effect, it is more likely that this result can be explained best with the Biopsychosocial Model. This can account for the improvement of both dog and relaxation conditions through the reduction of stress hormones with the results of the current study showing the significant effect of both interventions on cortisol levels (see results at subsection 11.2.6 above). This result will be discussed further in the conclusion.

As with the cognition results in the previous subsection, dog-assisted interventions applied as either one-to-one or group sessions showed no difference in the processing of language, with neither scenario providing enhancement to the processing of sentence comprehension or grammar. These results therefore support the hypothesis that no difference would be found between session types for children's language processing when children took part in dog-assisted interventions.

In contrast to the dog-assisted interventions, the relaxation sessions were most beneficial if carried out as one-to-one sessions, but this was only evident for grammar immediately after intervention and not for comprehension, additionally no other effects were found for relaxation under session type across consecutive test times. It can therefore be concluded that relaxation carried out as one-to-one sessions was more beneficial to children's processing of grammar than when carried out as a group, but this did not last past the post-intervention test time. Overall the results relating to the processing of language means the hypothesis must be rejected as differences were found between session types when taking part in relaxation sessions but not when taking part in dog-assisted sessions.

11.4.3 Effect of session type and intervention condition on socio-emotional measures of self-esteem and anxiety

Children's scores for self-esteem and anxiety did not benefit by being in either the one-to-one or group interventions and no differences were observed based on session type. These results therefore supported the hypothesis that group and individual sessions would lead to the same improvements for children's socio-emotional wellbeing scores.

11.4.4 Effect of session type and intervention condition on behaviour

As with the socio-emotional measures above, scores of classroom behaviour showed no beneficial effects for being in either the one-to-one or group interventions when assessed in relation to either the relaxation or dog interventions specifically. Interestingly, an interaction for condition with dog ownership was only present when children took part in group intervention sessions, which was not present for children who took part in the one-to-one sessions. A difference in classroom behaviour scores was found for children with a dog at home who were rated as having better behaviour overall, but not for those with no dog at home. This was regardless of the intervention which children took part in suggesting that the interaction was driven by cohort differences rather than session type. The results therefore support the hypothesis that group and individual sessions will lead to the same improvements in children's behaviour.

11.4.5 Effect of session type and intervention condition on cortisol

Baseline measures of cortisol supported the hypothesis that group and individual sessions will lead to the similar improvements with no differences based on session type Again this result is interesting given that social support can effect physiological function (Ozbay, Johnson, Dimoulas, Morgan, Charney & Southwith, 2007; Rosal, King, Ma & Reed, 2004) and validating social support can result in decreased cortisol (Heinrichs, Baumgartner, Kirschbaum & Ehlert, 2003; Slatcher, Selcuk & Ong, 2015). Consequently, it would have been expected that those in the group sessions may have benefited from this test scenario over those in the one-to-one interventions, but there was no difference between individual and group dog interventions with the response pattern the same for both. Interestingly, whilst not significant, those in the group relaxation condition do show a greater reduction in cortisol to those on the one-to-one sessions. Future research will be needed in order to assess the effect further.

In summary, one of the main reasons for assessing session type within the study was the potential cost savings to schools (and other organisations employing the services of AAI), and the benefits to therapy animals who would be engaged in less working hours if sessions worked effectively as a group intervention. While group interventions were carried out effectively and were enjoyed by the children, the dog intervention shows clearer benefits for cognitive tasks if carried out as one-to-one session scenarios.

It is possible that the individual intervention sessions provided a more personal experience for the child as they had sole interaction with the dog and handler, and the potential for a higher quality of interaction. Whilst intervention features were the same for both types of sessions, such as learning facts about the dog, and time playing games with the dog, children in group-interventions did not have as much direct contact with the dog and handler. Observation of the sessions also highlighted that the one-to-one sessions tended to be both calmer and quieter than the group sessions. Additionally, children in the one-to-one sessions were usually in closer proximity to the dog and had more opportunity to directly touch the dog than those who took part in group sessions who sat in a more structured 'circle time' type activity. This could potentially have led to stronger impacts of oxytocin and cortisol levels for those in the one-to-one sessions (Polheber & Matchock, 2014; Odendaal & Meintjes, 2003; Millot & Filiatre, 1986; Millot, Filiatre, Gagnon, Eckerlin & Montagner, 1988; Hall, Liu, Kertes & Wynne, 2016; Schöberl, Wedl, Beetz and Kotrschal, 2017; Petersson, Unväs-Moberg, Nillson, Gustafson, Hydbring-Sandberg & Handlin, 2017) which ultimately could result in beneficial effects on cognitive tasks due to the integrated neurological processes known to be involved in attention, executive function and motivational systems (Lupien et al., 2000; Diamond & Lee, 2011; Mowbray, 2012; Miyake et al., 2000; Rebetez et al., 2014; Schulz et al., 2007; Phelps, Ling & Carrasco, 2006).

Whilst one-to-one sessions show benefits for cognitive processing tasks within this study, the group interventions may actually be more beneficial for different types of behavioural interventions such as self-regulation or resilience support. Future investigations should ideally assess quantitative and qualitative differences of interaction with a dog in a systematic fashion. In addition to the amount of time spent in interventions with a dog, it would be preferable to assess the amount of direct contact time touching and petting a dog. This should also include further assessment of the difference between children completing tests whilst with the dog is in the room, in contrast to tests conducted after interventions have ended. An RCT longitudinal design together with physiological data would allow the tracking of qualitative versus quantitative effects, and the assessment of longevity for each.

11.5 Hypothesis 5: Effect of gender

No gender differences were expected. Differences in scores based on gender were few within this study. As predicted, overall no differences between boys and girls were revealed for any of the standardised measures of cognition collected through the BAS. However, for maths scores, boys performed significantly better than girls. Whilst this data is in line with past performance data (Bedard & Cho, 2010; Ganley & Lubienski, 2015; DCSF, 2009; DfES, 2007), this is contrary to current local, and national trends within educational UK attainment data which demonstrates the efforts being applied to close the gender gap in educational attainment outcomes (Department for Education; Standards & Testing Agency, 2018). Analysis of both one-to-one and group session data also showed that boys performed significantly better on the maths tests than girls, demonstrating a consistent result across schools and test sessions.

An interaction of condition with gender in language comprehension revealed that both boys and girls had a significant increase in scores when taking part in the relaxation interventions but only girls showed the same effect in the dog interventions. The small to medium effect size demonstrated that gender did not account for a large amount of variance within the model. Once analysis was carried out to assess session type of one-to-one and group, the interaction with gender was no longer present.

As expected, and regardless of intervention condition, a main effect for gender was present in the EQ scores with girls scoring higher on the empathy quotient (EQ) than boys. This is in line with previous research and was an expected result for the baseline data (Auyeung et al., 2009; Baron-Cohen, et al., 2005). Results for empathising scores were similar over all conditions, which is in line with the hypothesis that no gender differences would be present. This result is interesting when discussed in light of previous research which suggests girls are better able to assess empathy (Bosacki & Astington, 1999; Baron-Cohen, O'Riordan, Stone, Jones, & Plaisted, 1999; Baron-Cohen, Wheelwright & Hill, 2001) and that close relationships with dogs can have a positive effect on children's social behaviours and empathizing skills (Schmid, 2011; Hawkins, Williams & SPCA, 2017; Williams, Lawrence & Muldoon, 2010; Melson, 2003; Melson, Peet & Sparks, 1992; Bryant, 1985). The results here show that dog interventions did not impact on either girls or boys empathy scores over and above those of the relaxation sessions. It could be that the quality of interaction during the twenty-minute interactions over the school term may not be sufficient to influence children's empathy. Alternatively, as empathy involves several components and follows a developmental trajectory (Decety, 2010), it may not be as malleable to the effects of AAI over a short period of time.

No significant differences were found for gender in baseline cortisol levels however session-one pre acute cortisol, girl's cortisol was significantly higher than that found in boys. This difference was no longer present in the post-intervention acute cortisol samples and was independent from intervention condition. It could be that the girls suffered more pre-intervention stress at the first session than boys, and that after interventions, cortisol measures reduced to a baseline level which was in line with their own and the boy's measures at the start of the study. As in the discussions above in this thesis, previous literature does point to the positive effects of both relaxation and dog interventions in reducing cortisol. This is also confirmed by the results of this study.

Children's self-esteem scores for boys and girls who took part in group interventions differed. Girls showed a significant increase in self-esteem over the length of the study compared to boys who did not. Self-esteem scores were also somewhat different between boys and girls at baseline, albeit not significantly, but less so at the end of the study as girls demonstrated significant improvements. Engaging with the study, regardless of intervention condition, may have been enough to increase the scores of self-esteem in girls overall. Further investigation of this increase in girls' scores is worthy, as self-esteem is a significant contributor to children's academic competence (Daniel & King, 1997; Mann, et a., 2004) and also reflects a child's confidence and ability to deal with stress (Harter, 2012) (see subsection 4.3.1 for detailed discussion).

In a similar manner, and potentially linked, gender differences were also found for measures of anxiety but only for the group cohort, with girls demonstrating a significant reduction in anxiety over the course of the study, whilst boys did not. As effects were not found for the condition which children took part in, this result could be linked with the self-esteem scores above however further study would be required in order to tease these factors apart.

11.6 Hypothesis 6: Effect of dog ownership

No dog ownership differences were expected

11.6.1 Effect of dog ownership on cognition and language

Children's sentence comprehension scores (SC) revealed an effect for dog ownership with gender whereby girls with a dog at home performed significantly worse over the year, compared to boys with a dog who improved similar to girls who were not dog owners. Scores for these girls without a dog at home showed significant improvement past the post-intervention test time, whereas boys without a dog at home made significant improvements from the 6-month assessment. Overall, assessments carried out from baseline to the one year test time showed that all children made highly significant improvements in SC over the school term which would suggest developmental and maturation effects regardless of gender and dog ownership (see Hypothesis 1).

Interestingly, the maths task showed an effect for dog ownership with time, whereby children who had a dog at home had no significant improvement in maths scores between any of the consecutive test times whilst the children without a dog at home improved significantly between the baseline and post-intervention test only. This improvement for those who did not own a dog was present regardless of the intervention condition which children took part, but was not consistent over time with no further improvements past the post-intervention test time. This piece of research is the first experimental study to be conducted to look at the effects of AAI on children's performance in maths ability and it can be concluded that overall, AAI showed no beneficial effects for maths scores. The small effect size, paired with the small amount of variance accounted for within the model for dog ownership, means that this result should be viewed with some caution. So far, the results from this study do not advocate the application of AAI in schools for assistance with children's maths abilities. Further research assessing the effects of AAI on the mechanisms at work during maths tasks is therefore required. Overall for most measures of cognition and language it can be concluded that the hypothesis of no differences for dog ownership was supported.

11.6.2 Effect of dog ownership on behaviour

Children's classroom behaviour as reported by the teacher showed that children who were dog owners were judged to show better classroom behaviour than those who did not have a dog. Higher scores reflected children having better self- regulation and social skills. Although dog ownership knowledge could have potentially affected the ratings given by the teacher, it is assumed that they would not necessarily be aware of which children were from dog owning families. However, as it was possible to check this reliability beforehand, this could be a potential confound to the teacher assessments. A difference based on dog ownership in relation to intervention condition was also present and showed that children in the control condition who lived with a dog were rated with having the best behaviour, whilst children in the dog condition and who had no dog at home were rated with the poorest classroom behaviour scores. This result again fits with the Biopsychosocial model, and shows links with the salivary cortisol results found within the study. Children who took part in AAI sessions had lower baseline cortisol which has previously been linked with increased externalising behaviours (Alink, van Ijendoorn, Bakermans-Kranenburg, Mesman, Juffer & Kot, 2008; Shirtcliff, Granger, Booth & Johnson, 2005). Further work would need to be carried out in relation to this result to see the types of behaviours that children rated highly on, such as sociability, cooperativeness and self-regulatory behaviours, and whether these differed based on dog ownership. Incidentally, children's behaviour at home scores within this study, as rated by parents, showed no such effects for dog ownership.

11.6.3 Effect of dog ownership on self-esteem

AAI in conjunction with dog ownership did not appear to have a significant effect on children's self-esteem. Self-esteem was higher for the dog-owning children in the dog and control conditions, but lower for children withouy a dog at home. In contrast, the children in the relaxation intervention had lower self-esteem if they had a dog at home than if they did not have a dog at home, however, no significant differences were found between conditions based on dog ownership status of the children. Previous research highlights the benefits of animals on people's self-esteem (see Purewal, et al., 2017) but variability of scores based on dog ownership has not previously been assessed. The hypothesis that self-esteem would show no difference based on dog ownership status was upheld with no baseline differences present in the data. Additionally, no consistent benefit for the effect of AAI on self-esteem in conjunction with dog ownership was present either.

11.6.4 Effect of dog ownership on anxiety

Measures of anxiety showed that children who took part in the relaxation interventions and who had a dog at home had higher anxiety than those who had no dog at home. As with the self-esteem measures above, no differences in anxiety were present in either dog or non-dog-owning children at the start of the study and there was a consistent lack of effects for the benefit of AAI in improving children's reports of anxiety. As with the self-esteem data above, this study does not observe the positive effects already reported for dog-ownership on children's anxiety (Gadomski et el., 2018; Purewal, et al., 2017). Therefore, the results do fit with the current project's hypothesis that there will be no difference in children's levels of anxiety based on dog ownership status.

11.6.5 Effect of dog ownership on cortisol

No differences were found in baseline cortisol between children who did, and those did not have a dog at home, however, children in the relaxation intervention saw a significant increase in cortisol over the school term if they had a dog at home. This was not the case for the children in the relaxation sessions who did not have a dog at home, who saw a decrease in cortisol but this did not reach significance. No other conditions showed this effect based on dog ownership.

Additionally, this result is supported by the acute measures of cortisol which also showed a significant difference based on dog ownership per test condition. Children in the relaxation condition who did not have a dog at home saw a significant decrease in acute cortisol after relaxation sessions at sessions four and eight, whilst those who had a dog at home did not. This could be interpreted as the presence of a dog having a stronger effect on children who were not used to having regular contact with a pet dog, which resulted in a more dramatic decrease in cortisol during interventions than for dog owners. This difference was not seen for children in the dog interventions where levels of cortisol were moderated by the AAI and therefore only smaller reductions in acute cortisol were possible.

These results correspond with previous literature (Odendaal & Meintjes, 2003; Petersson, et al., 2017) but not with the hypothesis that there will be no difference in stress hormones based on dog ownership and interaction with AAI. Of note is that at the beginning of the study, no differences in cortisol levels were found between children based on dog ownership status. This means that subtle differences in stress responses were taking place depending on whether the child lived with a dog. Investigating this was beyond the scope of the current thesis and would need further research. Further work around the intensity and quality of interactions, as well as novelty factors also need to be investigated. Linked back to the Biopsychosocial model, this may also determine that none-dog-owning children could potentially benefit more from interventions with a dog by displaying a stronger decrease in cortisol. This seems likely given the effect size for the interaction observed within this study.

CHAPTER 12: Final conclusions

In conclusion, this longitudinal assessment of dog-assisted interventions within schools has produced some highly interesting findings. The study did this by employing the highest possible scientific rigour using randomised controlled trials, the gold standard for measuring and evalustion interaction effects. The most stiking finding is the moderating effect of dog-assisted interventions on children's stress levels. The cortisol data presented within this thesis represents original and novel findings, with acute cortisol measures taken before and after each intervention session, in addition to baseline cortisol which represented stress levels taken at the beginning and end of the school term. Of interest is not solely the fact that dog interventions had a clear moderating effect on children's stress levels, for both acute and baseline, but also the important observation that children's cortisol levels increased across the school term. This contributes much needed independent evidence of stress in childhood populations to the wider literature (Sadler et al., 2017, see Dimolareva et al for overview) and can now be followed by a recommendation how to moderate this successfully via dog-assisted interventions.

Tests of cognition and language were also affected by the dog intervention with most improvements seen immediately after intervention. In conjunction with the physiological data, it is likely that cognitive functions such as attention, executive function and short-term memory have benefited from the presence of a dog (see also Ling et al., 2016) as stress and anxiety can negatively impact on executive function and working memory processes (Lupien et al., 2000; Diamond & Lee, 2011; Mowbray, 2012). Studies such as Gee et al., (2007, 2009, 2010a, 2012a) and Bassette & Taber-Doughty (2013), report that animal-assisted interventions affect children's motivation and engagement during cognitive tasks. This could also account for the immediate effects of the dog condition found within this study.

It is worth mentioning that the relaxation interventions did also demonstrate some positive effects on children's functioning. In addition, the relaxation sessions sometimes produced effects which were not observed until later at the six-week test time. These somewhat delayed effects are worthy of further investigation. The acute cortisol measures within this study also show the effectiveness of relaxation in reducing stress hormones, but not until the fourth and eighth intervention sessions, it may therefore be that relaxation interventions require more time to become effective.

On the whole, the results from the study lend support to the Biopsychosocial model of stress reduction (Friedmann & Gee, 2017), whereby multiple factors of biological, psychological and social functions of the child are interacting and are affected in combination by the dog intervention. This study narrows down the interventions that benefited children's cognitive performance, behaviour and socio-emotional wellbeing. A range of measures showed specific beneficial effects for the dog-assisted interventions, among them cognitive and language measures, in addition to salivary cortisol which represented a physiological measure that was out of the conscious control of the child, and provided a valid assessment of children's stress responses.

It is pertinent to emphasise that the application of Attachment Theory (Beetz, 2017), Attachment and Social Support Theory (Julius et al., 2013) and the integrative framework of Attachment and Neuro-Physiological Hypotheses (Julius, et al., 2013) all include an element of physiological function. Nevertheless, whilst there is little doubt that strong and lasting bonds are formed between humans and animals, especially in relation to pet ownership and companion animals, it is not feasible for these theories to fully support many of the research findings within this thesis, and wider research of AAI. Given that a prerequisite of attachment theory is the requirement for the development of a bond over time, these theories cannot account for the positive effects in research which consist of one-off experimental sessions.

This study included repeated exposure to dogs over a 4-week period, however, not all children saw the same dog each time as dogs and handlers were rotated across timetables and schools, in many cases the child will only have seen a dog once, for twenty minutes. Conversely, this could also account for the lack of results found within this study but this seems unlikely, given that children's cortisol measures showed a clear effect of the dog interactions.

Intervention type has been demonstrated as a potential factor in the positive results found within this study, whereby the individual one-to-one sessions produced overall more results not evidenced in the group intervention sessions. A distinction should be made between quality and intensity of interaction with, and without, the formation of a strong attachment relationship over time. The results from this thesis would suggest that rather than Attachment theory being the main driver for intervention effects, it should instead be seen as a factor within a dynamic Biopsychosocial Model of Stress (Friedmann & Gee, 2017). Attachment is twofold, it can be seen to represent a psychological element which is representative of the child's own patterns of attachment with significant others which the child brings to AAI. Furthermore, attachment can also be included as a dynamic factor within the model; i.e. as a measure of the strength of relationship formed with the animal during AAI sessions. This in turn interacts with the child's internal representation and so has the potential to impact on future behaviour which can be measured as an outcome of AAI. In this sense, one-off experimental-sessions could then be included within the same theoretical framework as pet and companion animal studies, as attachment is not seen as a prerequisite of the theory. Instead, attachment could be classed as a factor that is both resident within the child but is also adaptable, affecting outcomes of AAI and with the potential to change relationships depending on other factors within the model.

Not every test of cognition, language or behavioural function was significantly affected by the dog intervention. This can be seen as a positive finding as it dispels the popular myth that animal-assisted interactions are always successful and can be applied to any area of child development with successful outcomes. Animal-assisted interventions cannot, and should not, be seen as a replacement for good quality teaching and appropriate educational interventions tailored to the needs of the developing child. The results presented here suggest that animals may preferentially facilitate certain types of learning and performance over others and in particular, have a significant effect on stress reduction. The question of this research, “AAI what works?” has thus been answered and specified. The information gained on the usefulness of dog and relaxation interventions for specific areas of learning and wellbeing can now lead to changes in policy and learning environments.

A sound understanding is required regarding, not just the benefits, but also the application of AAI in order to ensure optimum outcomes for the child. This also has to guard against the unethical application of animals within AAI sessions. Whilst it may be novel to take animals into the educational setting, all stakeholders must be made aware that this can impact negatively on the animal involved. The increased popularity of buying services from online providers of AAI sessions should be treated with caution. Ultimately businesses need to create profit, and sadly these are often put before the welfare needs of animals who are all too often considered mere commodities. The current study included the application of companion animals who lived in the home environment with their volunteer handlers, and were affiliated with Pets As Therapy UK. A robust risk assessment was designed for the study and applied in all educational settings taking part. This included a strict protocol with clear guidelines on the health and welfare needs of the dogs within the study and contained an additional dog welfare plan. This also ensured the safety of animals and humans involved in the study, including children, dog handlers, teachers and researchers. Children were given clear guidance on what was considered appropriate behaviour around the dogs. Children, staff and dog handlers were also taught dog's stress-signalling behaviour before interventions took place. These risk-reducing strategies should be implemented as a minimum to any AAI interventions taking place within any setting, and a protocol should be followed to ensure best and consistent practice and treatment fidelity.

12.1 Limitations of the study

This longitudinal research project required the repetition of the standardised tests used to measure cognition and behavioural function of children. Despite test times differing between four weeks to six months, this may potentially have led to some practice effects and so increased the 'learning effect' for children across the length of the study. However, if this was the case, then all children were given the same opportunity to increase their scores equally through repetition of the tasks. Using randomised controlled trials ensured that the effects of the dog interventions were compared to an active control and a no treatment control group.

Analysis of the scores from the standardised measures also revealed limitations of their use. The standardised scales are designed to put children's performance in the context of their age and that of their peers. Toolkits are benchmarked using national performance of children to create standard age scores (SAS). If a child attains the same raw score between two assessments then their performance is maintained, however, if performance changes in a small way this may not be recognised as it remains with the child's SAS. A further issue was encountered when assessments occur close to a child's birthday, as they then need to gain a much higher raw score in order to maintain the same level of performance relative to their SAS. It may have also been useful to use the raw scores from the tests such as the BAS and

ACE in order to provide a more meaningful picture of children's actual development in scores relative to the condition which they took part in.

Few of the children in the study had exceedingly high measures of anxiety. As previously stated, this is positive from the perspective of the wellbeing of the children but may be an important factor in the lack of results found in relation to dog-assisted interventions within the study, as the range of scores was typically narrow. In addition, this study collected anxiety data through the use of the RCMAS short form which despite being validated may have limited the assessment of anxiety to a certain extent. The full RCMAS measure is designed to collate the source of a child's anxiety (defined separately as social, worry or physical). Using the short form made this analysis impossible due to the lack of answers within each domain. Future research investigating the effects of AAI on children's anxiety would benefit from using the full survey or an alternative one. Additionally, the recruitment of a population with higher anxiety, such as those with ASD or those presenting with mental health difficulties would allow the potential impact of the dog to be assessed relative to how anxiety manifests itself within the child.

Teacher ratings of children's classroom behaviour within this study were collected using an objective rating scale (CBRS), however, it is unknown whether the teacher was unaware of children's pet ownership. The questionnaire included questions relating to school readiness, self- regulation and social skills and whilst it is unlikely that such knowledge would have affected these ratings, it cannot be ruled out explicitly.

In order to assess the effects of AAI on children's wider functioning such as behaviour at home, sleep and empathising, parents were asked to complete questionnaires before interventions began and after they had ended. Additionally, parents were also asked for demographic information and pet ownership details. Parents were asked to provide contact details through children's consent forms, which allowed the sending of a link for the questionnaires via email. Alternatively parents were asked if they preferred a paper copy, which was then sent home with children. Unfortunately, not all questionnaires were completed which meant that there were limitations on the manner with which certain measures could be analysed, for example some of the larger ANOVAs could not be conducted and so two separate ones based on gender and dog ownership were required. Future studies should give more personalised options for parents, for example the offer of assistance in completing forms, either in person or over the phone (as not all parents may be literate, or have internet access), and phone calls or text reminders for busy families.

Related to the above limitation, the assessment of some of the factors such as anxiety or dog ownership was not always possible due to low cell sizes, especially where data was split based on session type. Whilst factors such a dog ownership and gender were roughly equal across the cohort, it was not possible to predict the number of children who would present with high/low anxiety or self-esteem. Recruiting specialist populations in order to test these areas further would therefore be required in order to compare these factors more widely.

Lastly, due to the complexity of the current research, it will be possible to add further analyses which will result in additional publications. However it was not possible to add further measures for the quality of the interactions between the children and dogs, or indeed, the interaction with the dog-handlers. As for safety and insurance reasons, the dog and their handler always have to come as a team, it is therefore not possible to completely exclude a potential effect of the additional human interaction which the child receives as a result of taking part in this intervention. However, in this project, different handlers and dogs were employed, to avoid particular bias towards one handler or a specific dog. Future research could systematically address these issues and make this one of the main topics of investigation.

12.2 Outlook, recommendations and future research

Original and pioneering contributions to the field of AAI have been presented within this thesis, all of which are worthy of further investigation. The current study also is the first to investigate the effects of session type on AAI with the one-to-one sessions showing an overall immediate benefit for cognitive processing tasks. Future studies should investigate dosage and longevity, as well as session type, and ideally assess differences between single test sessions carried out with, and without, a dog present at the time of testing. Wider combinations should also be considered involving repeated intervention sessions, where children are tested afterwards without a dog in close proximity. Answers to these questions will determine optimal benefits for all.

Lastly is a recommendation for the future. With the increasing popularity of AAI, and the practice of ‘School Dogs’ it is imperative that the results of this research are considered seriously. AAI in schools represents an exciting and engaging experience for the child (and teachers and researchers), but it is clear from this project that it does not always produce long term improvements across all areas of learning. Schools represent loud and busy environments at times and so have the potential to create stress for animals; professionals should therefore seriously consider, based on solid research evidence, whether the benefit for the child can be obtained without compromising the welfare of animals in the process. AAI carried out with these factors in mind will enhance the welfare of animals, result in good quality interactions for children, and beneficially enhance the field of AAI in the process.

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Further sources:

Waltham resources for grey lit:

https://www.waltham.com/document/human-animal-interaction/pets-in-child-health-and-development-child-mental-health/299/

Waltham publication resource:

https://www.waltham.com/dyn/_assets/_pdfs/resources/WALTHAM_publications_1960-2016.pdf

Habri Central:

(https://habricentral.org/resources/)

Animals and Society Institute:

(https://www.animalsandsociety.org/human-animal-studies/society-and-animals-journal/)

Appendix 1: Research protocols

<u>Protocol for collection of data through standardised screening tools</u>
Please note that GSR data was collected over the course of the project but analysis was outside of the scope of this thesis due to time constraints.

1. **General guidelines**
    - Each child to be given their participant code at the beginning of the study (see section 8 below). This will be displayed at the top of a sticker collector card which they will bring to each of the screening sessions with them. They can collect stickers as they work through the project over the year. This ensures that the correct code is used for the same child at every stage of testing and provides a double check for the researcher at the beginning of each session.
    - BAS-3 and the ACE to be administered in alternate order across all children.
    - Each individual child to be administered the BAS-3 and the ACE in the same order at each of the test phases during the length of their participation in the project to ensure consistency of the GSR data.

<u>ORDER OF ADMINISTRATION FOR THE SCREENING TOOLS</u>

1. RCMAS-2 (Revised children's manifest anxiety scale)
CFSEI-3 (Culture free self-esteem inventories)
(both tests to be administered one after the other starting with the RCMAS, short version)

Researcher: "Now I am going to ask you some questions about yourself and how you feel. Have a think about the question and then just answer yes or no. There are no right or wrong answers. Just answer how you feel." If you are ok to continue then we will begin."
BUTTON PRESS GSR

2/3. BAS-3 (British Ability Scales)

Researcher: "now we are going to do some tasks that require you to attend carefully and use your thinking skills. There are four in total and they do get harder as we go along. Every time we start a new task we will press the button on the GSR watch you are wearing. If you are ok to continue then we will begin."
Researcher then administers the test battery using the wording from each of the tasks as set out by the BAS-3 technical manual.

BUTTON PRESS GSR

Appendix 1: Research protocols

<u>Protocol for collection of data through standardised screening tools</u>
Please note that GSR data was collected over the course of the project but analysis was outside of the scope of this thesis due to time constraints.

2/3. ACE (Assessment of Comprehension & Expression)
Researcher: "now we are going to do some tasks that require you to attend carefully and use your language skills. There are two in total, after we have done the first one we will press the button on the GSR watch you are wearing. If you are ok to continue then we will begin."
Researcher then administers the test battery using the wording from each of the tasks as set out by the ACE technical manual.
BUTTON PRESS GSR

4. Maths test
Researcher: "I now have a quick maths sheet for you to complete. Could you write your special code on the top of the sheet before we begin please?"
Researcher: "I would now like you to complete these maths tasks for me as fast as you can please. If you are ok to continue, you can begin once we have pressed the button on the GSR watch you are wearing."
BUTTON PRESS GSR

5. Categorisation task
Researcher: "We now have a fun game to play on our laptop."
Researcher asks the child to re-confirm which is their preferred hand? This should have been previously determined and should be the arm not currently wearing the GSR watch.

Researcher: "You will see a series of pictures on the screen. Some of the objects belong at the Seaside and others belong on the Farm." I would like you to tell me where each object belongs by pressing the buttons on this box." Researcher demonstrates how to position hand on button box and then says "I would now like you to press the blue button if you think the object belongs at the seaside, and the green button if the object belongs on the farm. I would like you to play the game as fast but as accurately as you can please."

Researcher: "Can you show me which buttons you are going to press to play the game?" If child gets them wrong or is unsure, repeat the process above.
Researcher: "Can you put your fingers on the buttons ready please, we will now press the button on the GSR watch and if you are ok to continue then we will begin."
Researcher inserts child participant code and activates program by pressing key on laptop. Program completion will return a blank screen on the laptop.
Researcher: "Well done you have sorted all the objects."
BUTTON PRESS GSR

Appendix 1: Research protocols

<u>**Protocol for collection of data through standardised screening tools**</u>
Please note that GSR data was collected over the course of the project but analysis was outside of the scope of this thesis due to time constraints.

6. Fruit Stroop task

Researcher: "We now have a further game to play called a 'Fruit Stroop' task.
Researcher: "This task requires you to complete three different sheets. Write your special code on the top of each sheet before we begin please. Each child is presented with three different sheets in random order.

Incongruent condition
"Each line contains a picture of either an apple, banana or pear printed in the wrong colour, and to the right-hand of the page are a set of colours (red, green, yellow). I want you to tick the correct colour that the fruit should be as quickly and accurately as possible."

Congruent condition
"Each line contains the outline drawing of either an apple, banana and pear with no colour, and to the right-hand side of the page, are a set of colours (red, green, yellow). I want you to tick the correct colour that the fruit should be as quickly and accurately as possible."

Neutral condition
"Each line contains the drawing of either a circle, triangle or rectangle, coloured in either red, yellow or green. To the right-hand side of the page, are a set of colours (red, green, yellow). I want you to tick the colour that the shape is as quickly and accurately as possible."

"If you get an answer wrong you can put a line through it and the tick the correct one instead."
Researcher: "You will have 30 seconds to complete each sheet. As before, I would like you to play the game as fast as you can, but also as accurately as you can please."
BUTTON PRESS GSR and remove from child as per GSR Protocol instructions

7. Debrief

- Researcher to thank child for taking part in the tasks. "Thank you for all your time in doing these tasks with me. How did you find that?" Is there anything you would like to ask me?"
- Researcher to make notes in the testing record comments box if the feedback from the child is relevant to the study.
- You can choose a sticker for your collection and add it to your collector card. We also have a small gift for you to say thank you for helping us with our study. When you get back to your classroom can you put it safely in your tray or bag until it is time to go home.

Appendix 1: Research protocols

8. Participant Code: Standard format for all testing

Child will be given their personal code which will consist of a number followed by their initials. The end of each code will change to reflect the stage of testing taking place.

Order	Code	Details
1	Child personal code number	Researcher1 to use 001 – 100 Researcher 2 to use 101+
2	Child's initials added	First name and surname initials
3	Cohort child assigned to	D = Dog R = Relaxation C = Control
4	Individual vs group	Individual = I Group =G
5	Testing session	B = Baseline assessment Ax = during intervention (A- Acute) followed by week number (x) as appropriate. T1 = Immediately after intervention T2 = 6 week follow up T3 = 6 month follow up T4 = 1 year follow up

Examples:

Mary Smith is in the individual relaxation group, her personal code is 23 and she was tested at the 6 month stage: 23MS-RI-T3

John Brown is in the group dog group, his personal code is 74 and he was tested immediately after intervention: 74JB- DG-T1

Appendix 2: Family background and Pet ownership questionnaires

Parent family background and pet-ownership questionnaire

Please complete all questions with a ball point pen.

Please shade in the circle to give your answer as shown.

The image part with relationship ID rId281 was not found in the file.

SES and Family Questionnaire

In order to compare our data to national averages we would ask that you complete the 12 questions below in relation to your child's early development and family background.

Please do not write your name or address on any part of this questionnaire so that the information is anonymous and confidential.

YOUR CHILD'S HEALTH AND DEVELOPMENT

1. At what week of pregnancy was your child born?	Week 33 or before	O	Week 34 to 36	O	Week 37 or later	O
2. How much did your child weigh at birth?	Up to 5lb 8oz	O	5lb 9oz to 9lb 14oz	O	9lb 15oz or over	O

3. How many siblings does your child have? (include full and half siblings)	0	O	1	O	2	O	3	O	4 or more	O

3a. What position is this child?	1st born	O	2nd born	O	3rd born	O	Other
3b. Is your child a twin/multiple birth?	Yes	O	No	O			

4. Is your child:

White British/Irish	O	Mixed Ethnicity: White and other	O	Asian/Asian British	O

Appendix 2: Family background and Pet ownership questionnaires

Black/African/Caribbean /Black British	O	Other ethnic group (please give details):

5. Which other people over 18 years old live in this home with you and your child?

Mum O	Dad O	Grandparent/s O			
Other related adults (please say how many)	0 O	1 O	2 O	3 O	more O
Other non-related adults (please say how many)	0 O	1 O	2 O	3 O	more O

6. How many other children live in your home with you? (please say how many in each age range)

Children 0-18 months	0 O	1 O	2 O	3 O	more O
Children 19 months- 3 years 11 months	0 O	1 O	2 O	3 O	more O
Children 4- 11 years	0 O	1 O	2 O	3 O	more O
Children 12 - 17 years	0 O	1 O	2 O	3 O	more O

7. How many bedrooms are in your home?	1 O	2 O	3 O	4 O	5+ O

Child's Mum

8. Child's mum's age is….	Up to 20 years old O	21-25 years old O	
26-30 years old O	31-35 years old O	36+ years old O	

Appendix 2: Family background and Pet ownership questionnaires

8a. Mum is…		Married/Civil Partnered	O	Living with partner	O
Single	O	Separated/Divorced	O	Widowed	O

8b. Mum's highest education is…		No formal qualifications	O	GCSE/O Level/NVQ Level 1 or 2/ similar	O
A Level/NVQ Level 3/ similar	O	University degree/HND/HNC/NVQ Level 4 or 5/similar	O	Postgraduate/similar e.g. (PGCE, PhD, MA etc.)	O

8c. Mum's work status is…		Not currently in work	O	Never worked, have only been in training or education	O
An employee	O	Self-employed (with employees)	O	Self-employed (without employees)	O

8d. Mum's current/last job title: (please be specific)

8e. How many people work for mum's employer or for mum if she is/was an employer? (only answer this question if mum is/was an employee or self-employed with employees)

0	O	1-24	O	25+	O

Child's Dad

9. Child's dad's age is…		Up to 20 years old	O	21-25 years old	O
26-30 years old	O	31-35 years old	O	36+ years old	O

9a. Dad is…		Married/Civil Partnered	O	Living with partner	O
Single	O	Separated/Divorced	O	Widowed	O

9b. Dad's highest education is…		No formal qualifications	O	GCSE/O Level/NVQ Level 1 or 2/ similar	O
A Level/NVQ Level 3/ similar	O	University degree/HND/HNC/NVQ Level 4 or 5/similar	O	Postgraduate/similar e.g. (PGCE, PhD, MA etc.)	O

9c. Dad's work status is…		Not currently in work	O	Never worked, have only been in training or education	O
An employee	O	Self-employed (with employees)	O	Self-employed (without employees)	O

9d. Dad's current/last job title: (please be specific)

9e. How many people work for dad's employer or for dad if he is/was an employer? (only answer this question if dad is/was an employee or self-employed with employees)

0	O	1-24	O	25+	O

10. What is the overall household income (before tax) per year in your child's main home?

£0-£14000	O	£14,001-£24,000	O	£24,001-£42,000	O	£42,001 or more	O

11. Does your child attend full time education? Yes O No O

11a. If no, how many hours do they attend in a typical week?

12. Does your child regularly hear a language that is not English? Yes O No O

12a. If yes, for how many hours does your child hear this other language in a typical week:

12b. If yes, what is this other language?

Appendix 2: Family background and Pet ownership questionnaires

Please complete all questions with a ball point pen.

Please shade in the circle to give your answer as shown.

The image part with relationship ID rId281 was not found in the file.

Pet Ownership Questionnaire

Animals play a major part in the lives of many people across the globe, with family pets often considered part of the family.

In order to help us further understand pet ownership in general, and interactions with dogs in particular, we would ask that you please complete the 12 questions below.

Please do not write your name or address on any part of this questionnaire so that the information is anonymous and confidential.

1. Do you have any pets? Yes O No O

1a. If yes, please tell us what type of animal they are:

1b. How many of each type do you have?

2. If you have a dog/s, what breed/s do you have?

If no, please go directly to Question 3.

2a. How old was your dog/s when you got it?

2b. Please tell us about any puppy training or similar courses you attended?

3. If you don't currently have a dog, how much contact has your child had with dogs in the last 2 years?

None O

Very Little (less than once per week) O

Moderate (once per week) O

Frequently (daily) O

Please give further information if you wish:

4. In general, does your child like animals? Yes O No O Only familiar ones O

Appendix 2: Family background and Pet ownership questionnaires

5. In general, does your child like dogs?	Yes	O	No	O	Only familiar ones	O
6. Is your child frightened of dogs?	Yes	O	No	O	Sometimes	O
7. If you own a dog, is your child frightened of it?	Yes	O	No	O	Sometimes	O

8. Have you ever been bitten by a dog (not including play)? Yes O No O

If No, please go directly to question 9

8a. If Yes, how many times and at what age/s where you bitten?

8b. Please rate the importance of the bite on a scale from 1 (small nip) to 5 (serious bite).

1 (small nip, mark on skin, no blood)	2	3	4	5 (serious bite, skin perforation, blood)
O	O	O	O	O

8c. When you were bitten was it?

A familiar dog O Your own dog O An unfamiliar dog O

9. Has your child ever been bitten by a dog (not including play)? Yes O No O

If No, please go directly to question 10

9a. If Yes, how many times and at what age was your child bitten?

9b. Please rate the importance of the bite on a scale from 1 (small nip) to 5 (serious bite).

1 (small nip, mark on skin, no blood)	2	3	4	5 (serious bite, skin perforation, blood)
O	O	O	O	O

9c. When your child was bitten was it?

Appendix 2: Family background and Pet ownership questionnaires

A familiar dog	O	Your own dog	O	An unfamiliar dog	O

10. Have you ever owned a dog (past or present) that bit any person, including yourself (not including play)?	Yes	O	No	O
11. Have you ever owned a dog (past or present) that bit a child under 18 years , (not including play)?	Yes	O	No	O

12. Please use this space to tell us any other information you think may be relevant to the above questions in relation to your family, dog bites and safety around dogs.

13. Please use this opportunity to tell us about your thoughts, feelings and general attitudes in relation to animals and pet ownership

Appendix 3: Behaviour at home questionniare

The image part with relationship ID rId281 was not found in the file.

Appendix 4: Protocol for the collection of salivary cortisol

<u>Protocol for the Collection of Salivary Cortisol</u>

2. **General guidelines**
   - Researchers to wear disposable gloves when collecting and handling any saliva samples.
   - Baby wipes to be available for use by children and researchers.
   - All saliva samples to be collected in the morning between the hours of 9.30am-12noon.This will ensure that teeth brushing, no food or sugary drink intake has occurred in the previous 30 minutes, in addition to no vigorous exercise having taken place prior to sampling taking place**.**
   - All baseline samples to be collected between 9.15 and 9.45am. Acute samples to be collected at time of intervention session between hours of 9.30 and 12noon as required. Children who are to provide saliva samples after breaktime will be asked to refrain from having a snack and to eat it after giving saliva.
   - Each child will provide saliva at the same time each day over the course of the study to ensure consistency across samples.
   - All collected samples will be recorded in an inventory, including participant code, date, time and sample/test stage. A comments section will also be completed to record notes on any specific issues or problems.

3. **Baseline cortisol collection**
   (Saliva samples to be collected on 3 consecutive days, 1 per day, per child)
   - Vials to be labelled with participant code details prior to children entering the room.
   - Groups of 3-4 children to give saliva samples at the same time and are collected from the classroom.
   - Salimetrics collection protocol to be followed to ensure consistency at all times (see section 3 below).
   - Explain to the children that our saliva can tell us a lot about how our body is working and we would like them to help us by providing saliva.
   - All collected samples to be double checked that they are labelled with a participant code, date and time and then are immediately placed into a cool bag for the morning.
   - All samples are then transferred to a -20˚c storage freezer at the University of Lincoln, Psychology Lab B for short term storage, for a maximum of 7 days.
   - Samples to be transported for external analysis and then destroyed.

Appendix 4: Protocol for the collection of salivary cortisol

Appendix 4, continued:

<u>Protocol for the Collection of Salivary Cortisol</u>

4. **Acute cortisol collection**
   (Saliva samples to be collected on sessions 1, 4 & 8 of intervention, 2 per day, per child)

- Vials to be labelled with participant code details prior to child entering the room.
- Individual children to give saliva samples at the beginning of the intervention session, they will then be asked to provide a further sample between 20-40 minutes after the intervention as finished (40-60minutes after child's initial sample taken).
- Salimetrics collection protocol to be followed to ensure consistency at all times (see section 3 below).
- Remind the child, that we have done this before and that our saliva can tell us a lot about how our body is working and we would like them to help us by providing saliva.
- All collected samples to be double checked that they are labelled with a participant code, date and time and then are immediately placed into a cool bag for the morning.
- All samples are then transferred to a -20 ˚c storage freezer at the University of Lincoln, Psychology Lab B for short term storage, for a maximum of 7 days.
- Samples to be transported for external analysis and then destroyed.

Appendix 5: Ethical approvals

EA2 **Ethical Approval Form: Human Research Projects**	**Please word-process this form, handwritten applications will not be accepted**	The image part with relationship ID rId281 was not found in the file.

This form must be completed for each piece of research activity whether conducted by academic staff, research staff, graduate students or undergraduates. The completed form must be approved by the designated authority within the College.
Please complete all sections. If a section is not applicable, write N/A.

1Name of Applicant	Prof. Kerstin Meints	
	School: Psychology	College: Social Science
2 Position in the University	Professor	
3Role in relation to this research	PI	
4Brief statement of main Research Question	**Investigating the effects of Animal-Assisted Intervention (AAI) on children – what works?** Investigating the effect of dog-assisted intervention on typically developing children and children with ASD/ADHD and coexisting learning difficulties in the classroom setting.	
5Brief Description of Project	This is an externally-funded longitudinal project with a duration of 3 years. MARS / Waltham are the funders and the project has undergone scrutiny by peer-reviewers and by the Mars/Waltham international research committee and received Ethical approval via the MARS / Waltham's research Ethics committee. The study: This is a longitudinal study looking at the effect of dog intervention and relaxation intervention in a classroom setting for children aged 8-9- years. There will be randomised controlled trials with the different populations (typical / special needs) and in 2 different intervention settings (individual intervention versus classroom-based group intervention).	

Appendix 5: Ethical approvals

	Children will be assigned at random to one of 3 intervention groups (with dog / with relaxation activity / no intervention control). Experimental, socio-emotional, physiological and cognitive and language measures will be taken before and after the intervention. This will demonstrate if the interventions have an effect on the measured abilities and physiological and socio-emotional states of the participants. Children will go through a dog familiarisation and dog safety training before the intervention. This will ensure that the results are not due to novelty effects of being with a dog in school for the first time. Measures: **SES and EQSQ:** Some of the baseline measures will be completed by the parents prior to starting the testing (SES- measuring socioeconomic status and EQSQ, measuring empathy). **Socio-emotional measures:** Children will be asked to complete the following baseline standardised measures at each point of testing: - Battle's Culture Free Self Esteem Inventory (CFSEI) (measuring self-esteem) - Revised Children's Manifest Anxiety Scale, **Cognitive and Language measures:** - Second edition (RCMAS-2) (2008) (measuring stress and anxiety) - ACE (measuring language) - British Ability Scales, Third edition (measuring cognition). - Experimental tasks on categorisation, language & maths: 10 minutes on laptop/eye-tracker measuring: Looking preferences / Eye-tracking, error rate, reaction times. **Physiological measures:** - Skin conductance: Each child will be asked to wear an E4 Empatica wristband https://www.empatica.com/e4-wristband which will measure galvanic skin responses while they are completing the standardised measures and during the individual intervention. - Cortisol / Oxytocin: Salivary cortisol/oxytocin samples will be collected from each participant using a "smell-and-spit" game with the children. This will require the child to smell a pleasant smell to stimulate saliva production and then spit into a purpose-made container. We will comply with common procedure to seal, label and place samples in a cooled container to then freeze them.

Appendix 5: Ethical approvals

<table>
<tr><td rowspan="2"></td><td colspan="2">Timeline:
Children will be tested on the standardised measures and language/cognitive task in schools initially (Test 1) and then straight after the last intervention to investigate immediate intervention effects (Test 2). They will again be tested 6 weeks after the last intervention for short-term effects (Test 3), after 6 months (Test 4) and 1 year (Test 5) for intermediate and long-term effects respectively.</td></tr>
<tr><td>Approximate Start Date:

1.1.2016</td><td>Approximate End Date:

31.12.20018</td></tr>
<tr><td rowspan="2">6Name of Principal Investigator or Supervisor</td><td colspan="2">Prof. Kerstin Meints</td></tr>
<tr><td>Email address:

kmeints@lincoln.ac.uk</td><td>Telephone:
01522 886474</td></tr>
<tr><td>7Names of other researchers or student investigators involved</td><td colspan="2">1. Victoria Brelsford
2. Mirena Dimolareva
3. Research administrator / lab and project manager (TBA)
4. Voluntary research assistants</td></tr>
<tr><td>8Location(s) at which project is to be carried out</td><td colspan="2">Primarily schools in Lincolnshire will be asked to take part. However, as the SEN schools usually have smaller class sizes it is possible that some schools are recruited from other counties.</td></tr>
</table>

<table>
<tr><td>9Statement of the ethical issues involved and how they are to be addressed – including a risk assessment of the project based on the vulnerability of participants, the extent to which it is likely to be harmful and whether there</td><td>Consent
Fully informed consent will be gained from the schools taking part.
Fully informed consent will be gained from each parent before the child is able to take part
Assent will be gained from all children prior to testing.
Brief
Each participant will be briefed:
Before completing the standardised tests and other measures
Before the collection of salivary cortisol
Before wearing the watch to measure galvanic skin responses</td></tr>
</table>

will be significant discomfort. **(This will normally cover such issues as whether the risks/adverse effects associated with the project have been dealt with and whether the benefits of research outweigh the risks)**	• Before completing the language/cognitive task • Before taking part in the dog or relaxation intervention Debrief Each participant will be given a debrief • After completing the standardised tests / measures • After the collection of salivary cortisol, • After wearing the watch to measure galvanic skin responses, • After completing the language/cognitive task • After taking part in the dog or relaxation intervention. Withdrawal • The parents have the right to withdraw their child's data at any point and up to 3 months after testing. • Each child is able to stop taking part in the testing at any point without having to give reasons. They will still get a sticker for participation. Confidentiality • All data is kept anonymous and confidential. Each child will have participant number on the record forms. Personal data will be stored in a locked cabinet in the Infant and Child Development Lab, Minerva Building, University of Lincoln. Whenever the school of Psychology moves, the data will again be stored in the new Infant and Child Development Lab in a locked cabinet – unless there will be a secure server be made available in future (like Liverpool's secure system) – in which case we would transfer the data securely onto this system. • Children will not be named in any reports. Allergies and Phobias • In order to protect children and their wellbeing, we will ask parents to declare phobias and allergies to dogs. The children affected will be able to take part in this study but will be placed in a group which requires no direct contact with a dog. If there are children with allergies against dogs / dog hair, we will agree a procedure with schools so to ensure that the testing room will be appropriately cleaned after usage. Child safety: • Only certified dog handlers with trained and certified therapy dogs will be present around the children. • Children will not interact with a dog before or after the sessions. • Children will never have to be alone with any of the researchers. • Children will never be alone with the dog handler, or the dog.

Appendix 5: Ethical approvals

	• If at any moment, the child shows any discomfort, the session will immediately be stopped. • Dog behaviour specialists, e.g. Prof. Tiny de Keuster (Universiy of Ghent) / Dr. Hannah Wright (University of Lincoln) will assess the dog handlers and dogs before study begins. • The dog will be on a leash while in the room with the child and while in school premise • Children, researchers, teachers and dog handlers will receive an additional dog safety training on safe behaviour with dogs (using Blue Dog) and dogs' body language and further advice from Prof. De Keuster and Dr. Wright before the study as part of the familiarisation to the dog. Dog safety: • To minimise dogs' distress we will recruit multiple dogs and dog handlers, each dog will only be allowed to work for about 2 hours with the children. • There will be regular breaks where the dog handler can give food treats and drink to the dog as appropriate. • If a dog should get restless or need a break, then we will interrupt testing. • If there are any signs of distress, we will stop testing or interrupt testing until the dog is happy to take part again. • If there are signs that the dog does not want to continue testing, then testing will be stopped.

Ethical Approval From Other Bodies

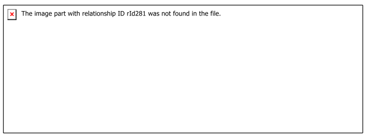
10 Does this research require the approval of an external body ?	**Yes x No ☐**
	If "Yes", please state which body:- **Mars / Waltham research committee and Mars / Waltham Ethics committee.**

Appendix 5: Ethical approvals

11 Has ethical approval already been obtained from that body ?	**Yes x -Please append documentary evidence to this form.** **No ☐** **If "No", please state why not:-** **Please note that any such approvals must be obtained and documented before the project begins.** **I can forward the email to the committee that the project has been approved. There is no other formal documentation about it as this is run via the Waltham/Mar research lead.**

APPLICANT SIGNATURE

I hereby request ethical approval for the research as described above.
I certify that I have read the University's ETHICAL PRINCIPLES FOR CONDUCTING RESEARCH WITH HUMANS AND OTHER ANIMALS.



____
15.10.2015_________________
Applicant Signature **Date**

Prof Kerstin Meints
____
PRINT NAME

FOR STUDENT APPLICATIONS ONLY –
Academic Support for Ethics
Academic support should be sought prior to submitting this form to the designated Ethics Committee within the Faculty

- ***Undergraduate / Postgraduate Taught application*** — ***A Academic Member of staff nominated by the School (consult your project tutor)***
- ***Postgraduate Research*** — ***Director of Studies***

Appendix 5: Ethical approvals

- ***Application***

I support the application for ethical approval

___________________________________ _________________
Academic / Director of Studies Signature Date

____
PRINT NAME

<u>FOR COMPLETION BY THE DESIGNATED ETHICS COMMITTEE WITHIN THE COLLEGE</u>

Please select ONE of A, B, C or D below:

☐ **A. Ethical approval is given to this research.**

☐ **B. <u>Conditional</u> ethical approval is given to this research.**

10 Please state the condition (inc. date by which condition must be satisfied if applicable)	

☐ **C. Ethical approval cannot be given to this research but the application is referred on to the University Research Ethics Committee for higher level consideration.**

11 Please state the reason	

☐ **D. Ethical approval cannot be given to this research and it is recommended that the research should <u>not</u> proceed.**

12 Please state the reason, bearing in mind the University's ethical framework, including the primary concern for Academic Freedom.	

Appendix 5: Ethical approvals

Signature of the Chair of the designated Ethics Committee within the College

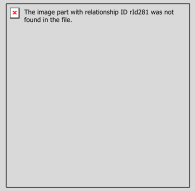
____
Signature **Date**

Chair of____
Please attach here:

Appendix 6: Risk assessment and Animal welfare plan

Lincoln Education Assistance with Dogs (LEAD)

School Risk Assessment Tool
-for research, educational or therapeutic interventions with <u>dogs</u> in educational settings



- This risk assessment is designed in accordance with the Society for Companion Dog Studies (SCAS) Dog-Assisted Interventions Code of Practice for the UK (June 2013)(www.scas.org.uk) and amended for the pruposes of this research.
- The SCAS voluntary code of practice offers both guidance on good practice for the delivery of dog-assisted interventions, in additon to ensuring that the welfare needs of both humans and dogs are met.
- This risk assessment is designed to reduce risk and ensure that interventions take place safely within the school setting.
- The research is approved by the Mars/Waltham research ethics committee and by the university of Lincoln Psychology research Ethics Committee (soprec@lincoln.ac.uk).

Please take the time to read the document carefully, assess in relation to your setting, sign and return to the research team/project manager.
If there are additional risks that apply to your setting, please complete sections B and C below as required and return to the research team/project manager for further action.

Appendix 6: Risk assessment and Animal welfare plan

PART A. ASSESSMENT DETAILS:			
Area/task/activity: Dog-assisted intervention in schools ***Name and address of lead researcher/ project manager:** **Location of activity:** Room in School			
School name: **Address & Contact details:**		**Name of Person(s) undertaking Assessment:**	
		Signature(s):	
Head Teacher (Name):		**Date of Assessment:**	
Signature:		**Planned Review Date:** **(Minimum 12 months)**	
How communicated to staff:		**Date communicated to staff:**	

PART B. HAZARD IDENTIFICATION AND CONTROL MEASURES				
Step 1: **Identify significant hazards**	**Step 2:** **Identify who might be harmed and how**		**Step 3:** **Identify precautionary measures already in place**	**Step 4:** **Identify person/s responsible**
List of significant hazards (anything with potential to cause harm)	**Who might be harmed?**	**Type of harm**	**Existing controls** (Actions already taken to control the risk)	**Name:**
All below:	Pupils, teachers, adult helpers, animal handlers	All below:	♦ Staff should also refer to any internal school policy, if existing, in relation to animals on school premises when organising an animal visit to school	♦
Hygiene	Pupils, teachers, adult	Infection, illness	♦ School infection control procedures to be followed at all times; ♦ School health & safety procedures to be followed at all times;	♦

	helpers, animal handlers		♦ Any significant cuts or abrasions on exposed skin of hands and arms should be covered before contact with the dog; ♦ Hand sanitizer gel and antibacterial wipes are provided for immediate use before and after contact with the dog; ♦ Pupils and adults always wash their hands soon after contact with the dog (or coming into contact with the dog's bedding, water, toys, etc.) and especially before snack/meal times; ♦ Further information, including facts about zoonotic diseases can be accessed from http://www.publichealth.hscni.net/directorate-public-health/health-protection/zoonoses-infections-acquired-animals	
Allergies, diseases, parasites	Pupils, teachers, adult helpers, animal handlers	Illness, allergic reaction	♦ Parents are asked to identify any pupils known to have allergic reactions to dogs. These pupils may have restricted access to dogs depending on their allergy trigger. ♦ In the rare case that an allergic reaction should occur and does not subside, medical assistance will be sought; ♦ The dogs will have been regularly taken to a vet and have been recently dewormed and treated for fleas; ♦ All waste produced, whether accidental or routine, is handled and disposed of hygienically and contaminated items and surfaces properly washed and disinfected in accordance with schools H&S procedures;	♦
Phobias	Pupils, teachers, adult helpers, animal handlers	Stress, adverse phobic reaction	♦ Parents asked to identify pupils known to have a phobia or fear reaction of dogs; ♦ All children will have familiarisation sessions before the interventions begin to ensure confidence and comfort levels of the children involved; ♦ Where there are pupils with phobias, dogs are not banned from coming into school, but every effort is made to segregate dogs from those with phobias;	♦
Safeguarding and protection of pupils: Human behaviour	Pupils, teachers	Dog handlers and researchers	♦ All researchers, educators and practitioners and dog handlers will check if they need a safety check carried out through the Disclosure and Barring Service (DBS check) (or equivalent outside UK) and will obtain one if deemed necessary; ♦ Children will never be left alone with dog handlers and will be supervised at all times when in the presence of a dog;	♦
Safeguarding children and adults: Dog behaviour	Pupils, teachers	Potential risk of Bites, scratches	♦ Checks are carried out by the research team prior to the visit to ensure that the dogs are suitable to work with children present; ♦ Dogs are closely supervised by their handler at all times; ♦ Dogs will not be allowed to wander unrestricted around the school; ♦ Pupils are closely supervised by an adult during intervention; ♦ Pupils are given safety training with regards to behaviour around dogs prior to interaction with the dog;	♦

			♦ Pupils will be taught to recognise stress signalling in dog behaviour prior to interaction with a dog (dog safety training); ♦ Access to a First Aider and First Aid kits are located in school; ♦ In the unlikely event that any dog scratches or bites may occur, these are carefully washed and a first aider contacted immediately; ♦ Any incidents to be recorded in accordance with school procedures and logged in incident/accident books as appropriate;	
Protection of dog	Dogs	Stress	♦ The dog handler is responsible for ensuring that their dog's physical and psychological wellbeing is protected and not comprised; ♦ Dog first aid kits will be provided and dog handlers are responsible for any first aid administered to dogs; ♦ The Dog Welfare Act (2006) and the Dog Health and Welfare Act (Scotland) should be adhered to at all times. These laws apply to all dog owners/keepers, but it is every adults' responsibility to be mindful of this guidance in their interactions with the dog. (see fawc.org.uk/freedoms); ♦ Dogs will be monitored for signs of stress by their handler and the researcher and removed from the situation should they judge the animal to be stressed or in discomfort; ♦ All dogs will be given access to water and an appropriate area for rest, toileting and exercise. Children will not be permitted to interact with the dog at these times; ♦ Dogs will work no longer than 2 hours per day in direct contact with children; ♦ If at any time during the intervention sessions a dog's welfare is in in danger of being compromised, the session will be stopped immediately; ♦ All dogs will have a care plan (see below) in place during their participation in the project ♦ a specialist consultant is assigned to the project and can be contacted for advice and guidance on dog welfare, behaviour and training throughout the study/intervention if required;	♦

I certify that the risk assessment above fully applies to the area/task/activity under assessment in:…………………… …… (Name of school)

Signed: Name: Risk Assessor.

Do not sign off above if further actions are required (see below Part C for further action).

Appendix 6: Risk assessment and Animal welfare plan

Part C:
If further action is required or there are further local significant hazards you think should be added, please record these actions here *in* Part C and sign off below.
Please return this document and the Action Plan at part C to the research/project team so that any additional issues can be acknowledged and acted upon asap.

PART C. ACTION PLAN – ADDITIONAL HAZARD IDENTIFICATION AND CONTROL MEASURES									
Further Significant hazards	**Who might be harmed?**	**Type of harm**	**Existing controls (Actions already taken to control the risk)**	**Further action / controls required**	**Person(s) responsible to undertake action**	**Priority**	**Projected time scale**	**Notes / comments**	**Date completed**

I certify that the assessment for the task/activity above covers all the significant hazards applicable:

……………..………………………………………………….. (Name of school)

Signed: Name: Risk Assessor.

Appendix 6: Risk assessment and Animal welfare plan

Dog Care Plan

Name of dog: ________________________________ Age: ________ Gender: _____________ Breed: ______________________

Name of handler: _________________________________

This Care Plan pertains to the welfare of dogs being used during intervention sessions with children in schools/ or participants in other settings. The Care Plan is part of, and should be read in conjunction with, the setting's / school's Risk Assessment document.
Areas relating to safety training with children/other participants and teaching correct behaviour with dogs is detailed in the main risk assessment

Care & treatment	Behaviour management	Feeding & watering	Toileting	Enrichment	Exercise
Visual health-checks will be carried out by handler before dog begins work in school/other setting. Dogs will be monitored throughout the interactive sessions to ensure their care and treatment is maintained to a high standard, including child/participant behaviour to ensure the dog is treated with respect. Dog handlers will have an animal first aid kit in order to administer emergency first aid in circumstances where this may be required.	During the intervention sessions, dog handlers and researchers trained in dog distress signalling will carry out constant observations of the child/dog interactions in order to detect signs of stress in the dogs. In the event that a dog becomes stressed the dog will be removed from the situation in order to protect the welfare of all concerned and allow the dog to feel comfortable in its surroundings.	Dogs will be fed before arrival at the school. Dogs will have constant access to water. Preferably no treats to be given, however, handler to decide on treats/rewards throughout sessions as they see fit. No treats to be given from hands of participants.	Designated areas for toileting will have been previously agreed between the school/other setting, the researchers and dog handlers in advance. Dogs will be taken outside at regular intervals as the handler sees fit, or as required by the dog during intervention sessions with the child/other participant.	Dogs may have a toy in the sessions in order to enable them to display their natural behaviours. Dogs will have a bed/blanket in a designated space in the room as a rest area away from human interaction and they should be given the opportunity to use it as they wish. Children/participants will not be permitted to approach the dog when the dog is in its resting space.	Designated areas for exercise will have been previously agreed between the school, the researchers and dog handlers in advance. When toileting the dog will be given time to exercise outside in order to enable them to display their natural behaviours and also as a break from direct contact with children.

Appendix 7: Recruitment letter and consent form

Parent recruitment letter and consent form

Infant and Child Development Lab
Department of Psychology
Brayford Pool,
Lincoln
LN6 7TS

Tel Infant Lab: 01522 886481

www.lincoln.ac.uk/psychology/babylab.htm

January 2015

Dear Parent/Carer,

The Infant Lab at the University of Lincoln has secured substantial research funding to carry out a unique and exciting research project with children and dogs. In this new project, we will investigate how the presence of a therapy dog improves children's mood, behaviour and learning in school.

We would like to ask if you would be interested to help us with our research.

What are we investigating?
Previous research highlights strikingly positive health and learning benefits of human-dog interactions. However, there is a lack of systematic research in this area. We have obtained funding to investigate how the presence of a dog affects children. Carrying out this research with 8-9-year-olds will help us understand how therapy dogs improve children's achievement and behaviour.

Why is this useful?
This project will help schools improve child wellbeing and educational outcomes to benefit children and families.

What exactly would we do?
We would bring a certified dog handler with their dog into the school to familiarise the children with the dog.
As part of the project, the research team will teach all children about interacting safely with dogs (about 30-45 minutes group session; could also be done in assembly for all children depending on the school's wishes).

- All children will complete a set of standardised measures with a trained researcher (measures of empathy, self-esteem, stress & anxiety, language and learning; as well as physiological measures to assess changes in children, for example hormone levels from saliva, to compare these with the other measures).Please note: To get saliva from the children we will be asked to spit into a little pot. We will then immediately freeze the samples and store them securely in a freezer at the University. Only research staff from the project will access the samples. Samples will not be labelled with the child's name. We will only use the samples to analyse children's bodily reaction to the dog/relaxation/control.
- Children will then be split randomly into one of the 3 groups (dog intervention, relaxation and control group).
- Children will then take part in 20-minute dog or 20-minute relaxation sessions for four weeks. The control group will do nothing.

- We would follow the children up after 6 weeks, 6 months and 1 year, just to repeat the measures (not the intervention) – this is so we know how long the effects of the dog or relaxation last.

How do we know if having a dog around changes anything?
We will compare the results of three groups: the dog intervention group, the relaxation group and the non-intervention control group to see if the dog and relaxation interventions had an effect.

What is your involvement?
We will ask you for written consent so your child can take part in the research. You would also be asked to complete a pet ownership and family questionnaire for which you will receive a £5 shopping voucher.

Welfare and Ethical considerations
The research is approved by the Mars/Waltham research ethics committee and by the University of Lincoln Psychology research Ethics Committee (soprec@lincoln.ac.uk).
All researchers are police checked and are highly experienced in carrying out research with children in schools. All data, including video-recordings of intervention sessions, will be anonymous, kept strictly confidential according to current data protection laws, only used for research purposes and stored in a secure location.

Children: Children are free to withdraw from the study at any point, parents are free to withdraw their children and their own data at any point up to two weeks after participation.

- Children in the dog sessions will be allowed to stroke or pat the dog if the handler decides it is appropriate.
- At no point will children be forced to touch the dog if they do not wish to.
- Parents will be asked whether their child has phobias related to dogs or allergies. Should this be the case, children could still take part in the study but be assigned to the yoga or control group.

Dogs: All dogs used in the project will be certified therapy dogs working with certified dog handlers (recruited, for example, through the **P**ets **A**s **T**herapy programme, PAT). In addition, they will be specially selected for the classroom environment. Our external consultants are dog behaviour specialists and will assess the dogs and their handlers and select them for the project. At no point will a dog be touched if the dog signals it does not want to be approached.

We would be very glad if you gave your consent for your child to take part in this exciting new study that will hopefully have a lasting impact on future teaching practice.

Please do not hesitate to contact the research team at the Infant Lab on tel: 01522 886481 or email us: babylab@lincoln.ac.uk

We are happy to discuss the project in more detail.

Yours sincerely,

Lincoln Infant and Child Development Team

Appendix 7: Recruitment letter and consent form

Principle Investigator: Prof Kerstin Meints - email: kmeints@lincoln.ac.uk 01522 886474
Researcher: Mirena Dimolavera – email: mdimolareva@lincoln.ac.uk
Researcher: Victoria Brelsford - email: vbrelsford@lincoln.ac.uk,

Consent Form

Investigating the effects of Animal-Assisted Intervention on Children

Consent form

I declare that I am the parent or legal guardian of ___________________________________
.
I have read the information letter and I am giving permission for my child to take part in the research.

Please delete as appropriate:

- Is your child currently taking any prescribed medication? **Yes/No**

- I can confirm that my child **does/does not** have an allergic reaction when exposed to contact with animals.

- I can confirm that my child **does/does not** have a phobia of dogs.

Please give any further details you think we should be aware of in relation to the allergy/phobia questions above:

Signed:______________________________

Parent Name (in block letters): _______________________________ Date:________

Email: ____

Daytime contact number: ________________________________

Appendix 8: Protocol for the familisation to dogs

<u>Protocol for the familiarisation of dogs prior to intervention</u>

1. **<u>Familiarisation setting:</u>**

The room the familiarisation will be carried out in will have:

- Dog blanket/bed
- Water bowl
- All dogs will have a care plan in place to ensure their welfare is safeguarded

2. **<u>Familiarisation process:</u>**

Only one dog will be familiarised with children at any one time within the school setting. Before it's familiarisation session with the children, each dog will come into the room with their handler and get used to the surroundings before children are introduced.
The dog will then go outside briefly while the children come into the room and take their seats. The dog will come back into the room and sit at the front of the class with their handler.

Each familiarisation session will begin with a reminder of the children's "Do's and Don'ts" protocol. This will set the ground rules for appropriate behaviour around the dogs, and set high expectations of each child in respecting the needs of the dog.
At this point, children will be invited to say hello to the dog and stroke him/her once, if they wish to. No child will be forced to approach to touch the dog if they do not want to.

The remainder of each session with the dog will consist of the children becoming familiarised with the dog in terms of knowledge about the dog, including the observation of the dog and its behaviour. The dog handler and researcher will encourage and answer questions from children in order to facilitate this process.

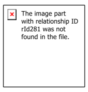
The children who wish to do so, can say goodbye to the dog and stroke him/her.

3. **<u>Familiarisation timing:</u>**

This familiarisation procedure will last approximately 15 minutes and each child will see each dog twice; children will therefore see each dog for half an hour for familiarisation.

Appendix 9: Children’s instructions for interactions

Children’s guidelines for child-dog interactions: Do’s and Don’ts



Do

- ✓ Ask the adult if you can stroke the dog
- ✓ Ask the dog if he/she would like to be stroked
- ✓ Look at the dog when you want his/her attention
- ✓ Be gentle with the dog
- ✓ Give the dog treats on a plate
- ✓ Wash your hands after stroking the dog
- ✓ Leave the dog alone if he/she is resting in his/her bed

Don’t

- × Don’t kiss the dog
- × Don’t hug the dog
- × Don’t give the dog food from your hand
- × Don’t take toys or food away from the dog
- × Don’t lie in the dog’s bed
- × Don’t lean into, or reach over the dog
- × Don’t put your face near the dog

Appendix 10: Spheritic and corrections for session type analysis

Section	Measure	Sphericity and corrections: one-to-one and group analysis
6.2.1.1	SNC: One-to-one	Data met the assumption of sphericity: Mauchly's (W (9) = .757, *p* =.062).
6.2.1.2	SNC: Group	Data met assumptions of sphericity: Mauchly's (W (9) = .847, *p* = .449).
6.2.2.1	NVR: One-to-one	Data met the assumptions of sphericity: Mauchly's t (W (9) = .778, *p* = .101).
6.2.2.2	NVR: Group	Data met the assumptions of sphericity: Mauchly's (W (9) = .758, *p* = .096).
6.2.3.1	Spatial: one-to-one	Data met the assumptions of sphericity: Mauchly's test (W (9) = .811, p = .202).
6.2.3.2	Spatial: group	The assumptions of sphericity were met: Mauchly's test (W (9) = .954, *p* = .980).
6.4.2.1	Fruit Stroop: One-to-one	Mauchly's tests reveals that data meets the assumptions of sphericity (χ^2 (9) = 14.281, *p* = .113).
6.4.2.2	Fruit stroop: Group	Mauchly's tests revealed that data met the assumptions of sphericity (χ^2 (9) = 23.764, *p* = .005).
6.4.3.1	Fruit stroop: One-to-one	Assumptions of sphericity were met: Mauchly's test (X^2 (9) = 12.863, p = .169).
6.4.3.2	Fruit stroop: Group	Data violated the assumptions of sphericity: Mauchly's test (X^2 (9) = 20.799, p = .014) therefore degrees of freedom are corrected using Huynh-Feldt estimates of sphericity
6.4.4.1	Fruit Stroop: SOP One-to-one	Data violated the assumptions of sphericity: Mauchly's test (X^2 20.307, p =.016) therefore degrees of freedom are corrected usi Huynh-Feldt estimates of sphericity.
6.4.4.2	Fruit Stroop: SOP Group	Data violated the assumptions of sphericity: Mauchly's test (X^2 21.285, p =.011) therefore degrees of freedom are corrected usi Huynh-Feldt estimates of sphericity.
6.6.1.1	Maths: One-to-one	Mauchly's test shows that data meets the assumptions of sphericity (X^2 (9) = 12.549, *p* = .184).
6.6.1.2	Maths Group	Data meets the assumptions of sphericity as demonstrated throu Mauchly's test (X^2 (9) = 8.661, *p* = . 469).
7.2.1.1	Categorisation Animacy: One-to-one	Data violated the assumptions of sphericity: Mauchly's test (χ^2 17.473, *p* = .042) therefore degrees of freedom are corrected us Huynh-Feldt estimates of sphericity.
7.2.1.2	Categorisation Animacy: Group	Mauchly's test shows that data meets the assumptions of spheri (χ^2 (9) 9.624, *p* = .382).
7.4.1.1	Sentence Comprehension: One-to-one	Mauchly's test shows that data meets the assumptions of spheri (χ^2 (9) = 14.019, *p* = .122).

Appendix 10: Sphericity and corrections for session type analysis

Section	Measure	Sphericity and corrections: one-to-one and group analysis
7.4.1.2	Sentence Comprehension: Group	Data met the assumptions of sphericity (χ^2 (9) = 8.831, p = .453
7.4.2.1	Syntactic formulation: One-to-one	Mauchly's test shows that data meets the assumptions of spheri (χ^2 (9) = 12.367, p = .194).
7.4.2.2	Syntactic formulation: Group	Mauchly's test shows that data meets the assumptions of spheri (χ^2 (9) = 5.524, p = .787).
8.4.1	Classroom behaviour: One-to-one	Levene's test showed that data does not violate homogeneity o variance: (F (5, 62) = .598, p = .701)
8.5.2	Self-esteem: One-to-one	Data violated the assumptions of sphericity: Mauchly's test (X^2 21.285, p < .001) therefore degrees of freedom are corrected us Huynh-Feldt estimates of sphericity.
8.5.3	Self-esteem: Group	Mauchly's test shows that data meets the assumptions of spheri (χ^2 (9) = 16.948, p = .050).
8.6.1	Anxiety: One-to-one	Data violated the assumptions of sphericity: Mauchly's test (X^2 35.874, p < .001) therefore degrees of freedom are corrected us Huynh-Feldt estimates of sphericity.
8.6.2	Anxiety: Group	Data violated the assumptions of sphericity: Mauchly's test (X^2 19.287, p=.023) therefore degrees of freedom are corrected usi Huynh-Feldt estimates of sphericity.
9.2.2	Baseline cortisol: One-to-one	Levene's test showed that pre-intervention data did not violate homogeneity of variance: Gender (F (5, 53) = .694, p = .630), Dog ownership (F (5, 53) = 1.351, p = .258)
9.2.3	Baseline cortisol: Group	Levene's test showed that pre-intervention data did not violate homogeneity of variance for Gender (F (5, 45) = .679, p = .64 But did for Dog ownership (F (5, 45) = 5.400, p = .001)

Appendix 11: Results overview: Cognition

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
BAS-3: SNC	All children	Time x condition x gender x dog-owner	Main effect of Time		<.001	.233
				Pre-post	<.000	
				Post – 6-week	<.000	
				6-week - 6-month	.057	
				6-month – 1-year	.698	
			Main effect of condition (NS) Effect of time with condition (NS)		.412 .147	.021 .035
				Pre to1-year	Dog <.001 Relax < .001 Control =.001	
				Pre-post	Dog <.001 Relax .002 Control .005	
				Post – 6-week	Dog <.001 Relax <.001 Control .363	
				6-week - 6-month	Dog .140 Relax .235 Control .660	
				6-month – 1-year	Dog .279 Relax .736 Control .158	
BAS-3: SNC	One-to-one	Time x condition	Main effect of Time		<.001	.260
				Pre-post	<.001	
				Post – 6-week	.006	
				6-week - 6-month	.553	
				6-month – 1-year	.644	
		Time x condition x gender x dog-owner	Main effect of condition (NS) Effect of time with condition (NS)		.139 .115	.260 .052

Appendix 11: Results overview: Cognition

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
BAS-3: SNC continued	One-to-one			Pre to1-year	Dog .002 Relax <.001 Control <.001	
				Pre-post	Dog <.001 Relax .005 Control .005	
				Post – 6-week	Dog .031 Relax .061 Control .363	
				6-week - 6-month	Dog .714 Relax .828 Control .660	
				6-month – 1-year	Dog .219 Relax .674 Control .158	
BAS-3: SNC	Group	Time x condition	Main effect of Time		<.001	.250
				Pre-post	.002	
				Post – 6-week	.000	
				6-week - 6-month	.026	
				6-month – 1-year	.271	
			Main effect of condition (NS) Effect of time with condition (NS)		.054 .238	.101 .046
				Pre to1-year	Dog <.001 Relax .002 Control <.001	
				Pre to post	Dog .365 Relax .138 Control .005	
				Post – 6-week	Dog <.001 Relax .003 Control .363	

Appendix 11: Results overview: Cognition

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
BAS-3: SNC continued	Group			6-week - 6-month	Dog .005 Relax .127 Control .660	
				6-month – 1-year	Dog .928 Relax .976 Control .158	
BAS-3: NVR	All children	Time x condition x gender x dog-owner	Main effect of Time		<.001	.059
				Pre-post	.001	
				Post – 6-week	.034	
				6-week - 6-month	.104	
				6-month – 1-year	.538	
			Main effect of condition (NS) Effect of time with condition (NS)		.431 .293	.020 .028
				Pre to 1-year	Dog .027 Relax .069 Control .246	
				Pre - post	Dog .030 Relax .122 Control .064	
				Post – 6-week	Dog .041 Relax .101 Control .555	
				6-week - 6-month	Dog .265 Relax .250 Control .713	
				6-month – 1-year	Dog .321 Relax .697 Control .578	
		Pre - post condition	Pre-Condition	Pre	.030	.066
			Post Condition (NS)	Post	.093	.043
	One-to-one	Time x condition	Main effect of Time		.003	.065

Appendix 11: Results overview: Cognition

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
BAS-3: NVR continued				Pre-post	<.001	
				Post – 6-week	.978	
				6-week - 6-month	.352	
				6-month – 1-year	.739	
			Main effect of condition (NS) Effect of time with condition (NS)		.103 .578	.073 .027
				Pre to 1-year	Dog .036 Relax .565 Control .246	
				Pre to post	Dog <.001 Relax .097 Control .064	
				Post – 6-week	Dog .800 Relax .831 Control .555	
				6-week - 6-month	Dog .667 Relax .474 Control .713	
				6-month – 1-year	Dog .901 Relax .311 Control .578	
BAS-3: NVR	Group	Time x condition	Main effect of Time		.001	.082
				Pre-post	.191	
				Post – 6-week	.011	
				6-week - 6-month	.141	
				6-month – 1-year	.916	
			Main effect of condition (NS) Effect of time with condition (NS)		.107 .200	.078 .048
				Pre -1-year	Dog .392 Relax .202 Control .246	

Appendix 11: Results overview: Cognition

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
BAS-3: NVR continued	Group			Pre-post	Dog .905 Relax .691 Control .064	
				Post – 6-week	Dog .017 Relax .016 Control .555	
				6-week - 6-month	Dog .214 Relax .347 Control .715	
				6-month – 1-year	Dog .250 Relax .487 Control .578	
BAS-3: Spatial	All children	Time x condition x gender x dog-owner	Main effect of Time		<.001	.278
				Pre-post	<.001	
				Post – 6-week	<.001	
				6-week - 6-month	.336	
				6-month – 1-year	.490	
			Main effect of condition (NS) Effect of time with condition (NS)		.787 .667	.018 .017
				Pre to 1-year	Dog .001 Relax <.001 Control <.001	
				Pre to post	Dog .001 Relax .019 Control .010	
				Post – 6-week	Dog <.001 Relax <.001 Control .137	
				6-week - 6-month	Dog .386 Relax .676 Control .761	

Appendix 11: Results overview: Cognition

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
BAS-3: Spatial continued	All children			6-month – 1-year	Dog .491 Relax .437 Control .196	
	One-to-one	Time x condition	Main effect of Time		<.001	.315
				Pre-post	<.001	
				Post – 6-week	<.001	
				6-week - 6-month	.809	
				6-month – 1-year	.637	
			Main effect of Condition (NS) Effect of time with condition		.311 .034	.038 .066
				Pre to post	Dog .001 Relax .169 Control .010	
				Post – 6-week	Dog .016 Relax .020 Control .137	
				6-week - 6-month	Dog .933 Relax .575 Control .761	
				6-month – 1-year	Dog .087 Relax .134 Control .196	
BAS-3: Spatial	Group	Time x condition	Main effect of Time		<.001	.288
				Pre-post	.001	
				Post – 6-week	<.001	
				6-week - 6-month	.068	
				6-month – 1-year	.163	
				Pre to 1-year	Dog <.001 Relax .002 Control <.001	

Appendix 11: Results overview: Cognition

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
BAS-3: Spatial continued	Group		Main effect of Condition (NS) Effect of time with Condition (NS)		.055 .185	.100 .049
				Pre to post	Dog .281 Relax .050 Control .010	
				Post – 6-week	Dog .002 Relax .011 Control .137	
				6-week - 6-month	Dog .109 Relax .219 Control .761	
				6-month – 1-year	Dog .096 Relax .442 Control .196	
Fruit Stroop: Congruency	All children	Time x condition x gender x dog-owner	Main effect of Condition (NS) Effect of Time with Condition (NS)		.767 .930	.005 .009
Fruit Stroop: Congruency	One-to-one	Time x condition	Main effect of time (NS)		.079	.034
			Effect of Time with Condition		.016	.073
				Pre to 1-year	Dog .099 Relax .355 Control .729	
				Pre to post	Dog .004 Relax .952 Control .173	
				Post – 6-week	Dog NS.044 Relax .737 Control .288	
				6-week - 6-month	Dog .104 Relax .896 Control .937	

Appendix 11: Results overview: Cognition

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Fruit Stroop: Congruency continued	One-to-one		Effect of Time with Condition	6-month – 1-year	Dog .569 Relax .569 Control .193	
		One way pre and post condition	Condition	Pre interference	.004	.154
			Condition (NS)	Post interference	.190	.050
Fruit Stroop: Congruency	Group	Time x condition	Main effect of Condition (NS) Effect of Time with Condition (NS)		.859 .979	.006 .009
Fruit Stroop: Colour process	All children	Time x condition x gender x dog-owner	Main effect of Condition (NS) Effect of Time with Condition (NS)		.250 .184	.015 .032
Fruit Stroop: Colour process	One-to-one	Time x condition	Main effect of Condition (NS) Effect of Time with Condition (NS)		.494 .273	.014 .039
Fruit Stroop: Colour process	Group	Time x condition	Main effect of Time (NS) Effect of Time with Condition		.135 .115	.036 .066
Fruit Stroop: SOP	All children	Time x condition x gender x dog-owner	Main effect of Time		<.001	.587
				Pre-post	<.001	
				Post – 6-week	<.001	
				6-week - 6-month	.004	
				6-month – 1-year	<.001	
			Main effect of Condition (NS) Effect of Time with Condition (NS)		.350 .781	.024 .014
				Pre to post	Dog <.001 Relax <.001 Control .001	
				Post – 6-week	Dog <.001 Relax .002 Control <.001	

Appendix 11: Results overview: Cognition

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Fruit Stroop: SOP continued	All children			6-week - 6-month	Dog <.001 Relax .049 Control .815	
				6-month – 1-year	Dog <.001 Relax .001 Control <.001	
Fruit Stroop: SOP	One-to-one	Time x Condition	Main effect of Time		<.001	.642
				Pre-post	<.000	
				Post – 6-week	<.000	
				6-week - 6-month	.024	
				6-month – 1-year	<.000	
			Main effect of Condition (NS) Effect of Time with Condition (NS)		.092 .247	.075 .041
				Pre to post	Dog .008 Relax <.001 Control .001	
				Post – 6-week	Dog .090 Relax <.001 Control < .001	
				6-week - 6-month	Dog .001 Relax .486 Control .815	
				6-month – 1-year	Dog .089 Relax .003 Control .001	
Fruit Stroop: SOP	Group	Time x condition	Main effect of Time		<.001	.582
				Pre-post	<.001	
				Post – 6-week	<.001	
				6-week - 6-month	.125	
				6-month – 1-year	<.001	

Appendix 11: Results overview: Cognition

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Fruit Stroop: SOP continued	Group		Main effect of Condition (NS) Effect of Time with Condition (NS)		.944 .341	.002 .037
				Pre to post	Dog .001 Relax .029 Control .001	
				Post – 6-week	Dog <.001 Relax .268 Control <.001	
				6-week - 6-month	Dog .486 Relax .049 Control .815	
				6-month – 1-year	Dog .001 Relax .109 Control <.001	
Maths	All children	Time x condition x gender x dog-owner	Main effect of Time		<.001	.125
				Pre-post	.012	
				Post – 6-week	.058	
				6-week - 6-month	.052	
				6-month – 1-year	.957	
			Main effect between Gender		.041	.049
			Main effect of Condition (NS) Effect of Time with Condition (NS)		.646 .348	.010 .026
				Pre to 1-year	Dog <.001 Relax <.001 Control <.001	
				Pre to post	Dog .487 Relax .392 Control .001	
				Post – 6-week	Dog .228 Relax .033 Control .766	

Appendix 11: Results overview: Cognition

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Maths continued	All children			6-week - 6-month	Dog .449 Relax .668 Control .021	
				6-month – 1-year	Dog .425 Relax .479 Control .761	
			Effect of Time with dog-ownership		.046	.029
				Pre to post	Dog owner .596 No Dog .004	
				Post – 6-week	Dog owner .099 No Dog .303	
				6-week - 6-month	Dog owner .993 No Dog .010	
				6-month – 1-year	Dog owner .721 No Dog .702	
Maths	One-to-one	Time x condition x gender x dog-owner	Main effect of time		<.001	.178
				Pre-post	<.001	
				Post – 6-week	.711	
				6-week - 6-month	.010	
				6-month – 1-year	.313	
			Main effect of Condition (NS) Effect of Time with Condition (NS)		.502 .280	.028 .049
				Pre to 1-year	Dog .003 Relax .328 Control <.001	
				Pre to post	Dog .033 Relax .020 Control .001	

Appendix 11: Results overview: Cognition

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
				Post – 6-week	Dog .598 Relax .741 Control .766	
				6-week - 6-month	Dog .292 Relax .373 Control .021	
				6-month – 1-year	Dog .652 Relax .037 Control .761	
Maths	Group	Time x condition x gender x dog-owner	Main effect of time		<.001	.137
				Pre-post	.409	
				Post – 6-week	.012	
				6-week - 6-month	.157	
				6-month – 1-year	.436	
			Main effect of Condition (NS) Effect of Time with Condition (NS)		.508 .078	.028 .070
				Pre to 1-year	Dog .046 Relax .015 Control .001	
				Pre to post	Dog .280 Relax .279 Control .001	
				Post – 6-week	Dog .018 Relax .014 Control .766	
				6-week - 6-month	Dog .959 Relax .981 Control .021	
				6-month – 1-year	Dog .506 Relax .374 Control .761	
			Main effect of Gender		.001	.222

Appendix 12: Results overview: Categorisation

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Categorisation	All children	Time x Animacy x Condition x Gender	Main effect of Time		.001	.109
				Pre – post	<.001	
				Post – 6-week	.002	
				6-week – 6-month	.337	
				6-month – 1-year	.641	
			Interaction of Time with Condition (NS)		.602	.020
				Pre to 1-year	Dog <.001 Relax <.001 Control .010	
				Pre – post	Dog .002 Relax.001 Control .234	
				Post – 6-week	Dog .030 Relax .152 Control .058	
				6-week – 6-month	Dog .911 Relax .220 Control .372	
				6-month – 1-year	Dog .198 Relax .404 Control .766	
			Main effect of Animacy		.001	.532
			Effect of Time with Animacy		.001	.204
				Pre	.001	
				Post	.001	
				6-week	.001	
				6-month	.001	
				1-year	.001	

Appendix 12: Results overview: Categorisation

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Categorisation continued	All children		Effect of Animacy with Condition		.026	.087
				Animate Inanimate	.610 .586	.010 .011
					Dog .532 Relax .449 Control .863	
		Time x Animacy x Condition x Dog ownership	Main effect of dog ownership (NS) Effect of time for dog ownership (NS) Effect of animacy with dog ownership (NS)		.931 .317 .945	.000 .015 .000
Categorisation	One-to-one	Time x Animacy x Condition xGender	Main effect of Time		.001	.132
				Pre – post	<.001	
				Post – 6-week	.009	
				6-week – 6-month	.908	
				6-month – 1-year	.474	
			Main effect of Condition (NS) Effect of Time with Condition (NS)		.243 .435	.057 .040
				Pre to 1-year	Dog .001 Relax .012 Control .009	
				Pre - post	Dog .011 Relax <.001 Control .265	
				Post – 6-week	Dog .086 Relax .310 Control .054	
				6-week - 6-month	Dog .204 Relax.602 Control.338	

Appendix 12: Results overview: Categorisation

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Categorisation continued	One-to-one			6-month – 1-year	Dog .059 Relax .594 Control.748	
			Main effect of Animacy		<.001	.654
			Main effect of Time with Animacy		<.001	.193
				Pre	<.001	
				Post	<.001	
				6-week	<.001	
				6-month	<.001	
				1-year	.148	
Categorisation	Group	Time x Animacy x Condition x Gender	**Main effect of Time**		< .001	.146
				Pre to 1-year	<.001	
				Pre - post	.002	
				Post – 6-week	.019	
				6-week - 6-month	.031	
				6-month – 1-year	.906	
			Main effect of Condition (NS) Interaction of Time with Condition (NS)		.582 .591	.024 .035
				Pre to 1-year	Dog .018 Relax <.001 Control .004	

Appendix 12: Results overview: Categorisation

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Categorisation continued	Group			Pre - post	Dog .064 Relax .198 Control .018	
				Post – 6-week	Dog .203 Relax .272 Control .117	
				6-week - 6-month	Dodg.270 Relax .144 Control .172	
				6-month – 1-year	Dog .743 Relax .528 Control .753	
			Main effect of Animacy		< .001	.408
			Main effect of Animacy with Condition		.003	.225
					Dog <.001 Relax <.001 Control<.001	
			Effect of Time with Animacy		<.001	.357
				Pre	<.001	
				Post	<.001	
				6-week	<.001	
				6-month	.294	
				1-year	<.001	
			Effect of Time with Animacy & Condition		<.001 `	.198
				Pre	Dog <.001 Relax .008 Control<.001	

Appendix 12: Results overview: Categorisation

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Categorisation continued	Group			Post	Dog <.001 Relax .002 Control<.001	
				6-week	Dog <.001 Relax .020 Control<.001	
				6-month	Dog .008 Relax .015 Control..482	
				1-year	Dog <.001 Relax .002 Control .327	
			Effect of Time with Condition & Gender		.038	.085
				Boys-Pre Boys-Post Boys-6-week Boys-6-month Boys-1-year	.701 .926 .991 .530 .590.	
				Girls-Pre Girls-Post Girls-6-week Girls-6-month Girls-1-year	459 .129 .333 .723 .831	
				Pre-Boys Pre-Girls	.701 .459	.023 .056

Appendix 13: Results overview: Language

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Sentence Comprehension	All children	Time x Condition x Gender x Dog-owner	Main effect of Time		.001	.231
				Pre - post	.001	
				Post – 6-week	.163	
				6-week - 6-month	.902	
				6-month – 1-year	.005	
			Main effect of condition (NS) Effect of time with condition (NS)		.068 .201	.061 .031
				Pre to 1-year	Dog <.001 Relax <.001 Control .005	
				Pre - post	Dog <.001 Relax .008 Control .032	
				Post – 6-week	Dog .263 Relax .055 Control.174	
				6-week - 6-month	Dog .682 Relax .374 Control .747	
				6-month – 1-year	Dog .495 Relax.011 Control	
			Effect of Time with Condition & Gender		.024	.050
				Boys Pre-post	Dog .098 Relax .014 Control .042	
				Boys Pre – 6-week	Dog .002 Relax .010 Control .490	

Appendix 13: Results overview: Language

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Sentence Comprehension continued	All children			Boys Pre - 6-month	Dog <.001 Relax .003 Control .173	
				Boys Pre – 1-year	Dog .004 Relax <.001 Control .021	
				Girls Pre-post	Dog <.001 Relax .150 Control .501	
				Girls Pre – 6-week	Dog <.001 Relax <.001 Control .124	
				Girls Pre - 6-month	Dog .007 Relax .002 Control .186	
				Girls Pre – 1-year	Dog <.001 Relax <.001 Control .094	
			Effect of Time with Gender & Dog ownership		.004	.044
				Boys Pre-post	Dog .001 No Dog .056	
				Boys Pre – 6-week	Dog .002 No Dog .017	
				Boys Pre 6-month	Dog .005 No Dog <.001	
				Boys Pre – 1-year	Dog <.001 No Dog <.001	
				Girls Pre-post	Dog .083 No Dog .008	
				Girls Pre – 6-week	Dog .015 No Dog <.001	

Appendix 13: Results overview: Language

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Sentence Comprehension	All children			Girls Pre - 6-month	Dog .152 No Dog <.001	
				Girls Pre – 1-year	Dog .009 No Dog <.001	
Sentence Comprehension	One-to-one	Time x Condition x Gender x Dog-ownership	Main effect of Time		.001	.228
				Pre - post	.001	
				Post – 6-week	.672	
				6-week - 6-month	.808	
				6-month – 1-year	.008	
			Main effect of condition (NS) Effect of time with condition (NS)		.273 .398	.049 .015
				Pre to 1-year	Dog .001 Relax <.001 Control .005	
				Pre - post	Dog .023 Relax .006 Control .032	
				Post – 6-week	Dog .431 Relax 1.00 Control .174	
				6-week - 6-month	Dog .344 Relax .851 Control .374	
				6-month – 1-year	Dog .267 Relax .086 Control .092	
			Effect of Time with Gender & Dog ownership		.002	.077
				Boys Pre-post	Dog .005 No Dog .117	

Appendix 13: Results overview: Language

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Sentence Comprehension continued	One-to-one			Boys Pre – 6-week	Dog .011 No Dog .446	
				Boys Pre 6-month	Dog .207 No Dog .202	
				Boys Pre – 1-year	Dog .163 No Dog .147	
				Girls Pre-post	Dog .084 No Dog .034	
				Girls Pre – 6-week	Dog .679 No Dog .046	
				Girls Pre - 6-month	Dog .414 No Dog .196	
				Girls Pre – 1-year	Dog .305 No Dog .195	
				Boys-girls 6-week	Dog .355 No Dog .221	
Sentence Comprehension	Group	Time x Condition x Gender x Dog-ownership	Main effect of Time		.001	.247
				Pre - post	.001	
				Post – 6-week	.191	
				6-week - 6-month	.571	
				6-month – 1-year	.049	
			Main effect of condition (NS) Effect of time with condition (NS)		.098 .190	.092 .056
				Pre to 1-year	Dog .001 Relax <.001 Control .005	
				Pre - post	Dog .004 Relax .328 Control .032	

Appendix 13: Results overview: Language

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Sentence Comprehension Continued	Group			Post – 6-week	Dog .440 Relax .019 Control .174	
				6-week - 6-month	Dog .427 Relax .551 Control .374	
				6-month – 1-year	Dog .845 Relax .070 Control .092	
			Effect of Time with Dog Owner		.022	.057
				Pre - post	Dog .016 No Dog .025	
				Post – 6-week	Dog .805 No Dog .105	
				6-week - 6-month	Dog .669 No Dog .704	
				6-month – 1-year	Dog .432 No Dog .056	
				Dog owner-No dog Pre	.890	
				Dog owner-No dog Post	.426	
				Dog owner-No dog 6-week	.626	
				Dog owner-No dog 6-month	.338	
				Dog owner-No dog 1-year	.201	
Syntactic formulation	All children	Time x Condition x Gender x Dog-owner	Main effect of Time		.001	.087
				Pre-post	.000	
				Post – 6-week	.103	

Appendix 13: Results overview: Language

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Syntactic formulation continued	All children			6-week - 6-month	.294	
				6-month – 1-year	.931	
			Main effect of condition (NS) Effect of time with condition (NS)		.258 .981	.031 .006
				Pre to 1-year	Dog .046 Relax <.001 Control .094	
				Pre-post	Dog .057 Relax .008 Control .033	
				Post – 6-week	Dog .324 Relax .330 Control .413	
				6-week - 6-month	Dog .594 Relax .671 Control .399	
				6-month – 1-year	Dog .714 Relax .733 Control 1.00	
Syntactic formulation	One-to-one	Time x Condition x Gender x Dog-owner	Main effect of Time		.001	.118
				Pre-post	<.001	
				Post – 6-week	.292	
				6-week - 6-month	.020	
				6-month – 1-year	.629	
			Main effect of condition (NS) Effect of time with condition (NS)		.283 .892	.347 .017
				Pre-post	Dog .044 Relax < .001 Control .033	

Appendix 13: Results overview: Language

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Syntactic formulation continued	One-to-one			Post – 6-week	Dog .545 Relax .737 Control .413	
				6-week - 6-month	Dog .075 Relax .148 Control .399	
				6-month – 1-year	Dog .716 Relax .602 Control 1.00	
Syntactic formulation	Group	Time x Condition x Gender x Dog-owner	Main effect of Time		.001	.113
				Pre-post	.089	
				Post – 6-week	.108	
				6-week - 6-month	.764	
				6-month – 1-year	.755	
			Main effect of condition (NS) Effect of time with condition (NS)		.154 .396	.073 .041
				Pre to 1-year	Dog .159 Relax .009 Control .094	
				Pre-post	Dog .637 Relax .693 Control .033	
				Post – 6-week	Dog .391 Relax .326 Control .413	
				6-week - 6-month	Dog .216 Relax .221 Control .399	
				6-month – 1-year	Dog .424 Relax .889 Control 1.00	

Appendix 14; Results overview: Social, Emotional and Behavioural

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Empathy Quotient	All children	Time x Condition x Gender	Main effect of Gender		.017 Girls higher than boys	.093
			Main effect of time (NS) Main effect for Condition (NS) Effect of Time with Condition (NS)		.452 .327 .377	.010 .037 .033
				Pre-Post	Dog .550 Relax .283 Control.625	
		Time x Condition x Dog ownership	No significant main effects or interactions present			
Systemising Quotient	All children	Time x Condition x Gender	Main effect of Time		.017	.092
			Main effect for Condition (NS) Effect of Time with Condition (NS)		.699 .095	.012 .077
				Pre-Post	Dog .244 Relax .938 Control .071	
		Time x Condition x Dog ownership	No significant main effects or interactions present			
Behaviour at home	All children	Time x Condition x Gender	Main effect of time (NS) Effect of Time with Condition		.169 .013	.032 .137
				Pre-post	Dog .007 Relax .601 Control .318	
				Pre intervention Post-intervention	.063 .764	.085 .009
Behaviour at home	All children	Time x Condition x Dog ownership	No significant main effects or interactions present			

Appendix 14; Results overview: Social, Emotional and Behavioural

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Classroom Behaviour	All children	Time x Condition x Gender	Main effect of time (NS) Effect of Time with Condition		.664 .033	.002 .067
				Pre-post	Dog .239 Relax .335 Control .067	
				Pre intervention Post-intervention	.950 .094	.001 .045
		Time x Condition x Dog ownership	Main effect of Dog ownership		.008	.069
			Effect of Condition with Dog ownership		.017	.079
				dog at home no dog at home	.059 .269	.135 .043
	One-to-one	Time x Condition x Gender	Effect of Time with Condition		.042	.097
				Pre-post	Dog .445 Relax .144 Control .067	
		Time x Condition x Dog ownership	No further significant main effects or interactions present			
	Group	Time x Condition x Gender	No significant main effects or interactions present		Dog .385 Relax .986 Control .067	
		Time x Condition x Dog ownership	Main effect of Condition		.036	.107
			Main effect of Dog ownership		.015	.096
			Effect of Condition and Dog ownership		.008	.151
				Dog owner No dog	.010 .343	.329 .058

Appendix 14; Results overview: Social, Emotional and Behavioural

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Classroom behaviour cont.				Dog owner: Dog-Relax Dog- Control Relax-Control	 .473 .625 .876	
Self-esteem (CFSEI)	All children	Time x Condition x Gender x Dog ownership	Main effect of Time		.001	.089
				Pre-post	.100	
				Post – 6-week	<.001	
				6-week – 6-month	.278	
				6-month- 1-year	.046	
			Main effect for Condition (NS) Effect of Time with Condition (NS)		.091 .918	.054 .009
				Pre to 1-year	Dog .076 Relax .002 Control .002	
				Pre-post	Dog .937 Relax .143 Control .209	
				Post – 6-week	Dog .021 Relax .018 Control .142	
				6-week – 6-month	Dog .935 Relax .448 Control .197	

Appendix 14; Results overview: Social, Emotional and Behavioural

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Self-esteem (CFSEI) continued	All children		Interaction of time with gender		.046	.028
				Pre-post	.044 <.001	
				Boys Pre-post Post -6-week 6-week – 6-month 6-month – 1-year	 .254 .005 .121 .555	
				Girls Pre-post Post -6-week 6-week – 6-month 6-month – 1-year	 .239 .020 .818 .019	
			Interaction between condition and dog ownership		.001	.144
				Relax-Dog	Dog .264 No dog .635	
				Relax – Control	Dog .177 No dog .561	
				Dog – Control	Dog .315 No dog .987	
Self-esteem (CFSEI)	One-to-one	Time x Condition x Gender x Dog ownership	Main effect of Time		<.001	.106
				Pre-post	.138	
				Post – 6-week	.006	
				6-week – 6-month	.415	
				6-month – 1-year	.050	

Appendix 14; Results overview: Social, Emotional and Behavioural

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Self-esteem (CFSEI) continued	One-to-one		Main effect of time (NS) Interaction of Time with Condition (NS)		.277 .828	.048 .020
				Pre to 1 year	Dog .069 Relax .047 Control .002	
				Pre-post	Dog .685 Relax .487 Control .209	
				Post – 6-week	Dog .057 Relax .153 Control .142	
				6-week – 6-month	Dog .782 Relax .932 Control .197	
				6-month – 1-year	Dog .323 Relax .142 Control .083	
			Interaction of Time with Condition and Dog ownership		.028	.078
				Dog condition-Dog owner Pre-post Post – 6-week 6-week – 6-month 6-month – 1-year	 .231 .078 .086 .022	
				Dog condition- No dog at home Pre-post Post – 6-week 6-week – 6-month 6-month – 1-year	 .883 .436 .085 .813	

Appendix 14; Results overview: Social, Emotional and Behavioural

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Self-esteem (CFSEI) continued	One-to-one			Relax sessions -Dog owner Pre-post Post – 6-week 6-week – 6-month 6-month – 1-year	1.000 .710 .737 .036	
				Relax sessions -No dog Pre-post Post – 6-week 6-week – 6-month 6-month – 1-year	 .484 .044 .808 .310	
				Control -Dog owner Pre-post Post – 6-week 6-week – 6-month 6-month – 1-year	 .140 .732 .542 .826	
				Control -No dog Pre-post Post – 6-week 6-week – 6-month 6-month – 1-year	 .391 .018 .028 .073	
Self-esteem (CFSEI)	Group	Time x Condition x Gender x Dog ownership	Main effect of Time		.003	.078
				Pre-post	.155	
				Post – 6-week	.006	
				6-week – 6-month	.150	
				6-month – 1-year	.117	

Appendix 14; Results overview: Social, Emotional and Behavioural

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Self-esteem (CFSEI) cont.	Group		Main effect of Condition		.044	.122
			Interaction of Time with Condition (NS)		.664	.030
				Pre to 1-year	Dog .660 Relax .018 Control .002	
				Pre –post	Dog .851 Relax .198 Control .209	
				Post – 6-week	Dog .187 Relax .067 Control .142	
				6-week -6-month	Dog .508 Relax .182 Control .197	
				6-month -1-year	Dog .484 Relax .100 Control .083	
			Interaction of Time with Gender		.010	.066
				Pre-1-year, girls Pre-1-year, boys Baseline gender NS	.001 .096 .112	.024
			Interaction of Condition with Dog ownership		.002	.233
				Dog owner	M = 7.06 M = 6.07 M = 7.12	

Appendix 14; Results overview: Social, Emotional and Behavioural

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Self-esteem (CFSEI) continued	Group		Interaction of Condition with Dog ownership, continued	No dog	M = 6.35 M = 6.49 M = 6.48	
				Dog owner No dog (NS)	.023	.280
Anxiety (RCMAS)	All children	Time x Condition x Gender x Dog ownership	Main effect of Time		.001	.070
				Pre-post	.460	
				Post – 6-week	<.001	
				6-week – 6-month	.417	
				6-month – 1-year	.087	
			Effect of Condition (NS) Interaction of Time with Condition (NS)		.089 .776	.055 .014
				Pre to 1-year	Dog .134 Relax .003 Control .013	
				Pre-post	Dog .546 Relax .211 Control .409	
				Post – 6-week	Dog .021 Relax .011 Control .139	
				6-week – 6-month	Dog .636 Relax .326 Control .196	
				6-month – 1-year	Dog .844 Relax .102 Control .114	

Appendix 14; Results overview: Social, Emotional and Behavioural

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Anxiety (RCMAS) Continued	All children		Interaction of Condition with Dog ownership		.002	.131
				Dog: No dog home Dog Relax Control	 .760 .004 .990	 .003 .201 .000
Anxiety (RCMAS)	One-to-one	Time x Condition x Gender x Dog ownership	Main effect of Time		.005	.069
				Pre-post	.523	
				Post – 6-week	.006	
				6-week – 6-month	.612	
				6-month – 1-year	.116	
			Interaction of Time with Condition (NS)		.929	.014
				Pre to 1-year	Dog .123 Relax .076 Control .013	
				Pre-post	Dog .840 Relax .665 Control .409	
				Post – 6-week	Dog .046 Relax .184 Control .139	
				6-week – 6-month	Dog .796 Relax .784 Control .196	
				6-month – 1-year	Dog .557 Relax .401 Control .114	

Appendix 14; Results overview: Social, Emotional and Behavioural

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Anxiety (RCMAS)	Group	Time x Condition x Gender x Dog ownership	Main effect of Time		.004	.076
				Pre-post	.405	
				Post – 6-week	.003	
				6-week – 6-month	.145	
				6-month – 1-year	.141	
			Interaction of Time with Condition (NS)		.451	.039
				Pre to 1-year	Dog .757 Relax .022 Control .013	
				Pre-post	Dog .522 Relax .225 Control .409	
				Post – 6-week	Dog .168 Relax .030 Control .139	
				6-week – 6-month	Dog .541 Relax .167 Control .196	
				6-month – 1-year	Dog .502 Relax .135 Control .114	
			Main effect of Condition		.024	.144
				Dog – Control	.619	
				Dog- Relaxation	.722	
				Relaxation-Control	.383	
			Main effect of dog ownership		.045	.081

Appendix 14; Results overview: Social, Emotional and Behavioural

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Anxiety (RCMAS) continued	Group		Interaction of Time with Gender		.009	.067
				Pre to 1-year < Girls Boys	 .004 .167	
			Interaction between Condition and Dog ownership		.001	.243
				Dog- No dog Dog Relax Control	. 522 .007 .522	
			Interaction of Time with Condition and Gender		.040	.080
				Boys Pre to 1 year	Dog .800 Relax .669 Control .071	
				Girls Pre to 1 year	Dog .869 Relax .005 Control .037	
				Boys Pre-post	Dog .332 Relax .703 Control .135	
				Boys Post – 6-week	Dog .511 Relax .367 Control .118	
				Boys 6-week – 6-month	Dog .442 Relax .107 Control .049	
				Boys 6-month – 1-year	Dog .461 Relax .448 Control .233	

Appendix 14; Results overview: Social, Emotional and Behavioural

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Sig (2-tailed)	η_p^2
Anxiety (RCMAS) continued	Group			Girls Pre-post	Dog .059 Relax .050 Control .636	
				Girls Post – 6-week	Dog .062 Relax .056 Control .463	
				Girls 6-week – 6-month	Dog .827 Relax .597 Control .779	
				Girls 6-month – 1-year	Dog .851 Relax .203 Control .283	

Appendix 15. Results overview: Physiological, salivary cortisol

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Direction	Sig (2-tailed)	η_p^2
Cortisol (Baseline)	All children	Time x Condition x Gender	Main effect of time		+	.001	.119
			Main effect of condition (NS) Effect of Time with Condition (NS)			.760 .442	.007 .019
				Pre-post	nc + +	Dog .212 Relax .013 Control .025	
		Time x Condition x Dog-ownership	Main effect of Time			.001	.142
			Effect of time with Condition & Dog ownership			.001	.212
				Dog owner	Dog (nc) Relax (+) Control (nc)		
				No Dog	Dog (nc) Relax (nc) Control (+)		
Cortisol (Baseline)	One-to-one	Time x Condition x Gender	Main effect of Time		+	.003	.154
			Main effect of condition (NS) Effect of Time with Condition (NS)			.386 .683	.035 .014
				Pre-post	nc nc +	Dog .289 Relax .013 Control .072	
Cortisol (Baseline)	Group	Time x Condition x Gender	Main effect of Time			.014	.128
			Main effect of condition (NS) Effect of Time with Condition (NS)			.542 .384	.027 .042
				Pre-post	nc nc +	Dog .539 Relax .205 Control .013	

Appendix 15. Results overview: Physiological, salivary cortisol

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Direction	Sig (2-tailed)	η_p^2
Acute Cortisol Intervention S1	All children	Time x Condition x Gender	Main effect of Time		Pre > post	.001	.212
			Main effect of Condition NS) Effect of Time with Condition (NS)			.495 .685	.008 .003
				Pre-post	- -	Dog .001 Relax .025	
			Main effect of Gender			.030	.077
				Pre	Girls higher than boys	.022	
				Post	No gender difference	.144	
		Time x Condition x Dog ownership	Main effect of Time		Pre > post	.001	.210
			Effect of Time with Dog ownership (NS)	Pre-post	- -	Dog .001 Relax .025	
Intervention S4		Time x Condition x Gender	Main effect of Time		Pre > post	.001	.207
			Main effect of Condition NS) Effect of Time with Condition (NS)			.854 .201	.001 .026
				Pre-post	- -	Dog .079 Relax .001	
			Effect of Time with Condition & Gender			.006	.115
				Boys	+ -	Dog .593 Relax .002	
				Girls	- nc	Dog Relax .001 .064	
		Tine x Condition x Dog ownership	Main effect of Time		Pre > post	.001	.164

Appendix 15. Results overview: Physiological, salivary cortisol

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Direction	Sig (2-tailed)	η_p^2
Acute Cortisol Continued Intervention S4	All children	Tine x Condition x Dog ownership	Main effect of Condition NS) Effect of Time with Condition (NS)			.990 .575	.000 .164
				Pre-post	- -	Dog .005 Relax .001	
			Effect of Time with Condition & Dog ownership			.026	.076
				Dog owner	nc nc	Dog .168 Relax .706	
				No dog	nc -	Dog .301 Relax .000	
Intervention S8	All children	Time x Condition x Gender	Main effect of Time		Pre > post	.003	.129
			Main effect of Condition (NS) Effect of Condition with Time			.108 .040	.039 .062
				Pre-post	nc -	Dog .275 Relax .005	
		Time x Condition x Dog ownership	Main effect of Time		Pre > post	.004	.121
			Main effect of Condition (NS) Effect of Condition with Time (NS)			.152 .057	.031 .054
				Pre- post	nc -	Dog .275 Relax .005	
Sessions 1, 4, 8	All children	Time x Condition x Gender x Dog ownership	Main effect of session (NS)			.087	.087
			Effect of Condition with session (NS)			.137	.045
			Effect of Time with Condition and Gender			.019	.122

Appendix 15. Results overview: Physiological, salivary cortisol

Assessment	Cohort	Test conducted and factors included	Effect	Planned comparisons & post-hoc tests	Direction	Sig (2-tailed)	η_p^2
		Test conducted and factors included	**Effect**	**Post-hoc tests**	**Direction**	**Sig (2-tailed)**	η_p^2
Acute Cortisol Sessions 1, 4, 8 continued	All children	Time x Condition x Gender x Dog ownership		Boys S1 pre-post	nc -	Dog .144 Relax .041	
				Boys S4 pre-post	nc -	Dog -.857 Relax .003	
				Boys S8 pre-post	nc nc	Dog .960 Relax .065	
				Girls S1 pre-post	- nc	Dog .046 Relax .998	
				Girls S4 pre-post	- nc	Dog .034 Relax .554	
				Girls S8 pre-post	nc -	Dog .329 Relax .036	
			Effect of time with Condition and Dog ownership	Dog owner S1 pre-post	- nc	Dog .043 Relax .558	
				Dog owner S4 pre-post	nc nc	Dog .080 Relax .477	
				Dog owner S8 pre-post	nc nc	Dog .592 Relax .524	
				No dog S1 pre-post	nc nc	Dog .203 Relax .119	
				No dog S4 pre-post	nc -	Dog .886 Relax .003	
				-	nc -	Dog .558 Relax.001	